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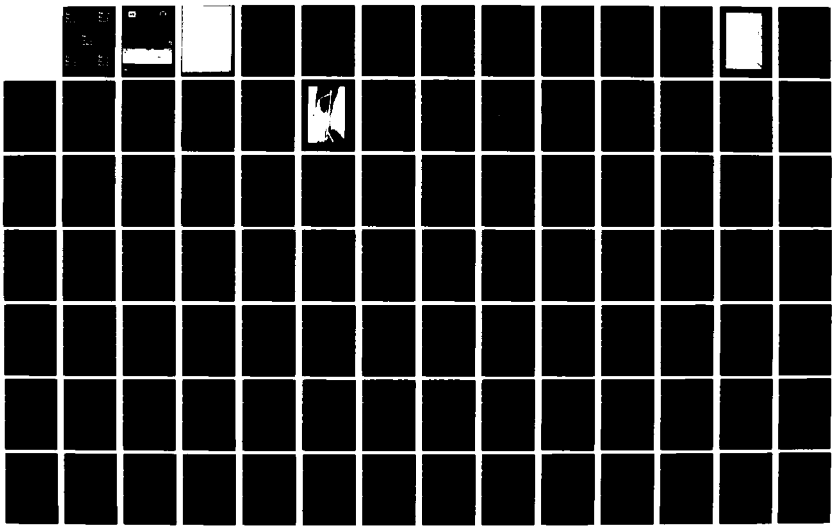

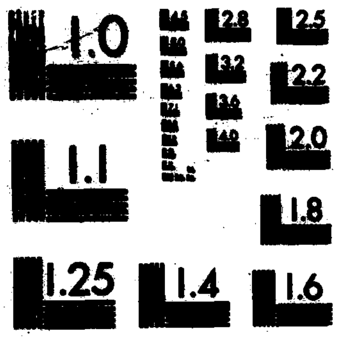

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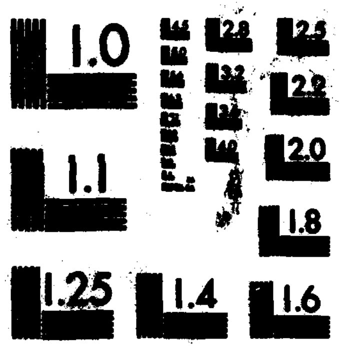

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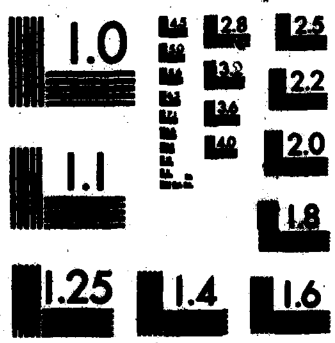

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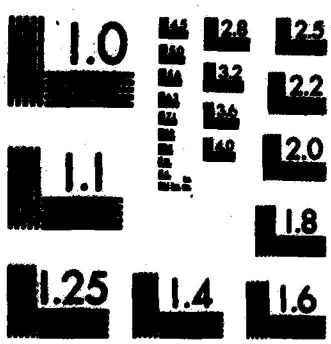

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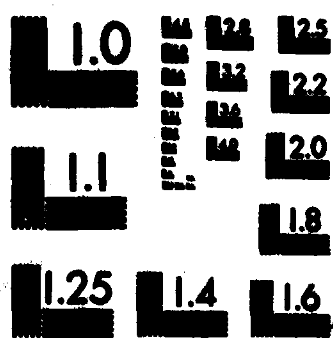

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TECHNICAL REPORT HL-82-18

DESIGN FOR FLOOD CONTROL, WAVE PROTECTION, AND PREVENTION OF SHOALING, ROGUE RIVER, OREGON

Hydraulic Model Investigation

by

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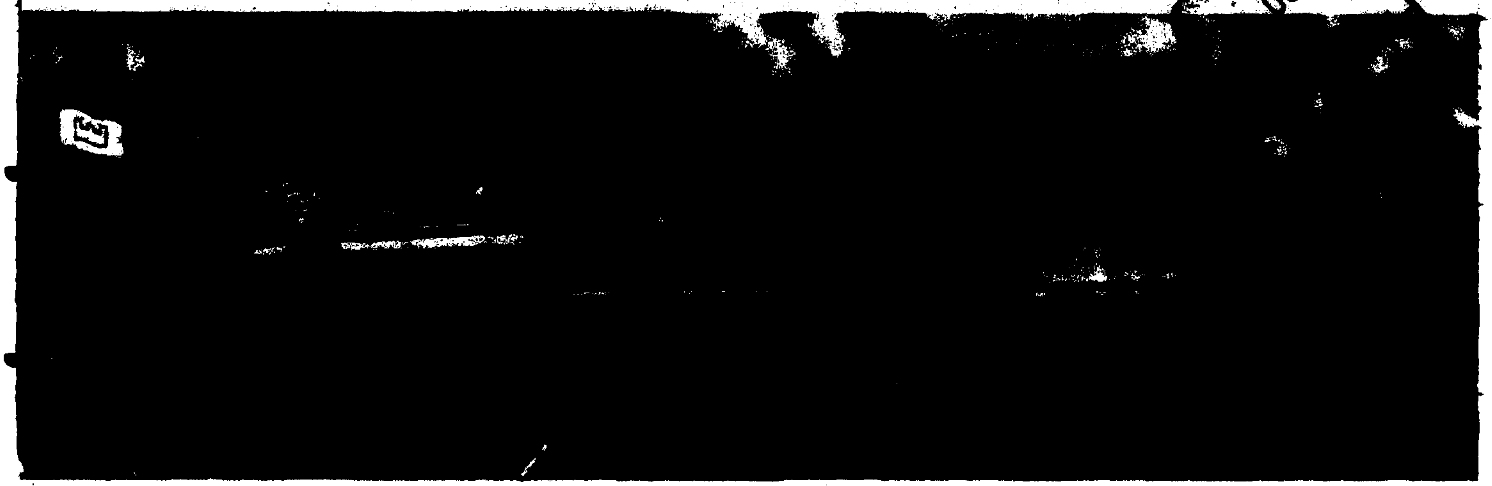
August 1982

Final Report



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A 1:100-scale (undistorted) hydraulic model of Rogue River, Oregon, which included the river from its mouth to a point approximately 6700 ft upstream, the Rogue River Small-Boat Harbor, approximately 7,000 ft of the Oregon shoreline on each side of the river mouth, and sufficient offshore area in the Pacific Ocean to permit generation of the required test waves, was used to investigate the effects of proposed improvements with respect to shoaling, wave action, and riverflow conditions. Proposed improvement plans consisted of (a) extensions and/or modifications of the present jetties; (b) dredging of a new entrance channel south of the existing one with an extension of the south jetty and construction of a new jetty; and (c) the installation of dikes extending into the channel from the south jetty both with and without a weir section and conveyance channel installed on the north jetty and overbank. An 80-ft-long wave generator, an Automated Data Acquisition and Control System (ADACS), a model circulation system, and crushed coal

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20. ABSTRACT (Continued).

tracer material were utilized in model operation. It was concluded from test results that:

a. During periods when the shoal is present (Base Test 1), rough and turbulent wave conditions exist in the entrance due to waves breaking on the shoal.

b. During periods when the shoal is present (Base Test 1), higher than normal river stages and river-current velocities may result for various discharges since the shoal interferes with the passage of flood flows.

c. During periods when the shoal is not present (Base Test 2), increased wave heights can be expected upstream of the small-boat harbor entrance.

d. Wave-induced shoaling will occur in the river entrance for existing conditions for various waves from each direction, and the shoal will migrate upstream across the small-boat harbor entrance for waves from west and/or southwest.

e. The installation of a timber-pile dike extending from the south jetty (Plans 1-1B) will not prevent shoaling of the small-boat harbor entrance channel.

f. The installation of the two rubble-mound dikes of Plan 2 and the three rubble-mound dikes of Plan 2A will prevent shoaling of the small-boat harbor entrance; however, each plan (Plan 2A to a lesser extent) will result in increased water-surface elevations upstream of the inner dike as compared with a no-shoal existing condition (Base Test 2).

g. The Plan 2A rubble-mound dikes extending from the south jetty have no tendencies for trapping river bed-load sediment upstream of the inner dike for the various discharges tested.

h. The conveyance channel and weir section of Plan 3A reduced river stages upstream by less than 1 ft and therefore were not successful in decreasing water-surface profiles to desired levels.

i. Of the improvement plans tested involving extensions of the existing jetties on their original alignment (Plans 4-4G and 5-5E), Plan 5E will provide shoaling protection from sediment on the north and south shorelines; however, sediment from the river will form a shoal in the entrance adjacent the south jetty that will extend upstream across the small-boat harbor entrance.

j. Of the improvements plans tested involving jetty extensions oriented toward the west on an azimuth of S 81°41'30" W (Plans 6-6D and 7-7J), Plans 7E and 7J will prevent shoaling of the entrance from sediment on the north and south shorelines; however, sediment from the river will form shoals in the entrance but will not extend upstream to the small-boat harbor entrance.

k. Of the improvement plans tested involving jetty extensions oriented toward the south on an azimuth of S 16°23'22" W (Plans 8-8D and Plan 9), Plans 8D and 9 will prevent shoaling of the entrance from sediment on the north and south shorelines; however, sediment from the river will result in a shoal along the south jetty extension extending northerly in the entrance. This shoal will not extend upstream to the small-boat basin entrance.

l. The jetty extensions of Plans 7J and 8D would have negligible effects on water-surface elevations in the lower reaches of the river for the various discharges.

m. Of the improvement plans tested involving a new entrance south of the existing river mouth (Plans 10-10J and 11-11B), Plan 11B will provide shoaling protection for the new entrance from sediment on the north and south shorelines and sediment deposited seaward of the river entrance by various discharges.

PREFACE

A request for a model investigation at the mouth of the Rogue River, Oregon, was initiated by the District Engineer, U. S. Army Engineer District, Portland (NPP). The study was authorized by the Office, Chief of Engineers, U. S. Army, and funds for the U. S. Army Engineer Waterways Experiment Station (WES) to conduct the study were authorized on 12 July 1979, 26 November 1979, 22 September 1980, and 23 December 1980.

The model study was conducted during the period May 1980-July 1981 by personnel of the Wave Processes Branch (WPB), Wave Dynamics Division (WDD), Hydraulics Laboratory, WES, under the direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory; Mr. F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory; Dr. R. W. Whalin, Chief of the WDD; and Mr. C. E. Chatham, Jr., Chief of the WPB. Tests were conducted by Messrs. M. G. Mize and H. F. Acuff, civil engineering technicians, and K. M. Strausbaugh, student trainee, under the supervision of Mr. R. R. Bottin, Jr., Project Manager. This report was prepared by Mr. Bottin.

Prior to the model investigation, Messrs. Bottin and Acuff and representatives of NPP visited the Rogue River site. During the course of the investigation, liaison between NPP and WES was maintained by means of conferences, telephone communications, and monthly progress reports.

Messrs. R. Flanagan, H. Herndon, P. Keough, D. Askren, L. Phinney, and K. Johnson of NPP visited WES to observe model operation and/or participate in conferences during the course of the model study.

Commanders and Directors of WES during the conduct of this investigation and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
pounds (mass)	0.4535924	kilograms
square feet	0.09290304	square metres
square miles (U. S. statute)	2.589988	square kilometres
tons (2,000 lb, mass)	907.1847	kilograms

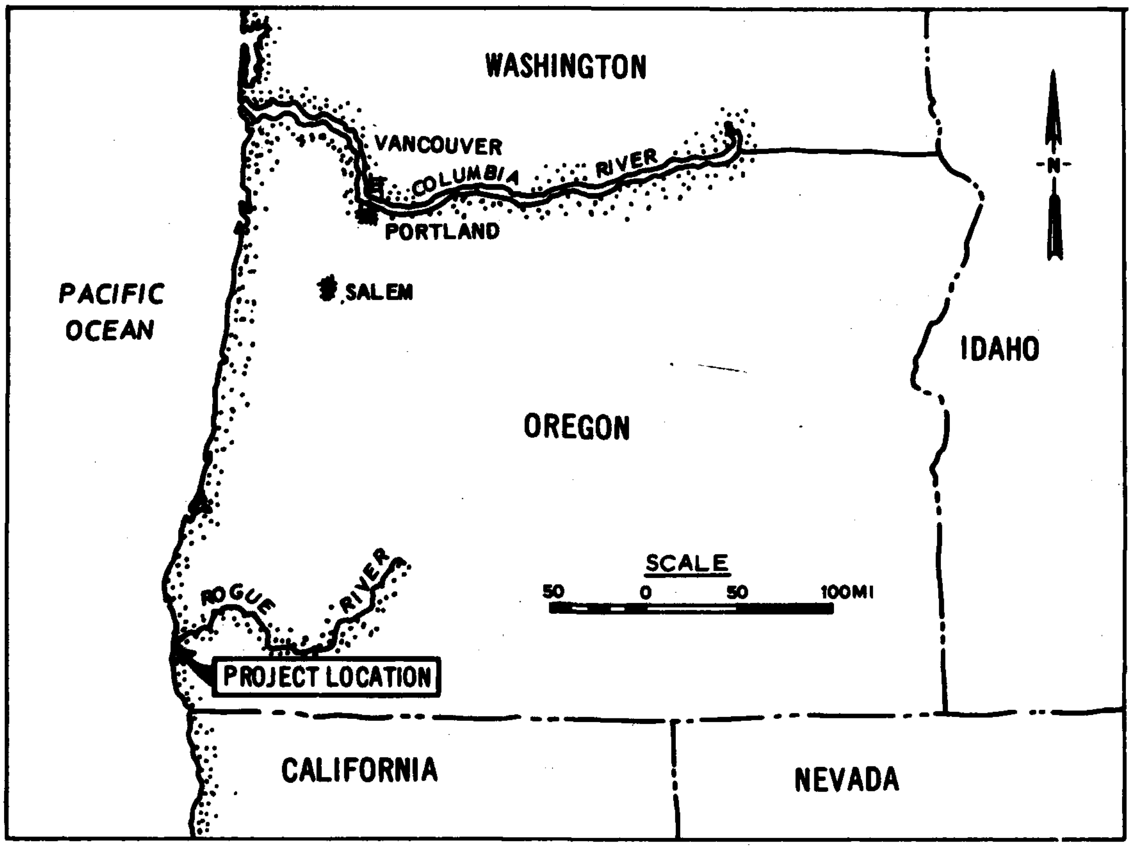

Figure 1. Project location

DESIGN FOR FLOOD CONTROL, WAVE PROTECTION AND PREVENTION OF SHOALING ROGUE RIVER, OREGON

Hydraulic Model Investigation

PART I: INTRODUCTION

The Prototype

1. The Rogue River originates in the Cascade Range and flows westerly and southwesterly where it enters the Pacific Ocean on the Oregon coast approximately 30 miles* north of the California border (Figure 1). It has a drainage area of 5,080 square miles (CTH 1970). The river has no significant bay, and only about the lower 4 miles are subject to tide influences (Hartman 1977). From this point upstream for about 80 miles, the river flows through the Siskiyou Mountains and has all the characteristics of a typical mountain stream. The Oregon Coast Highway (U. S. 101) crosses the Rogue River about 1 mile upstream of its mouth and connects the area with other coastal ports. The principal communities at the mouth are Gold Beach and Wedderburn, located on the south and north banks, respectively. These areas are generally developed for resort and recreational usage. Development consists of motels, charter boat services, dock and shore facilities, a warehouse, restaurants, and marine supply and sport shops.

2. Prior to improvement, the river channel at the mouth meandered between two sand spits and was seldom less than 200 ft wide at low water (Hartman 1977). Controlling depths over the entrance bar ranged from about 2 ft in late summer to 9 ft in winter. The controlling depth of the inner channel was about 6 ft for approximately 1 mile upstream.

3. The original Federal project for Rogue River at Gold Beach was

* A table of factors for converting U. S. customary units of measurements to metric (SI) units is presented on page 3.

authorized by the River and Harbor Act of 3 September 1954. It provided for construction of two jetties at the mouth of the river that were spaced approximately 1,000 ft apart; an entrance channel 13 ft deep and 300 ft wide from the ocean to a point just below the highway bridge; and a turning basin 13 ft deep, 500 ft wide, and 650 ft long about 1/4 mile below the bridge. Later modifications to the authorized project provided for an access channel 10 ft deep and 100 ft wide from the entrance channel to the Port of Gold Beach docks; a turning basin 10 ft deep, 150 ft wide, and 600 ft long adjacent to the docks; and revetment on the north bank extending approximately 2,450 ft downstream of the highway bridge. In 1971-1972, the Port of Gold Beach constructed a breakwater for protection of small boats moored in the small-boat basin. This breakwater extended from a point on the south bank about 1,000 ft above the highway bridge downstream to an extension of the south jetty. A gap was left in the breakwater to provide access to harbor facilities.

The Problem

4. Every year, a persistent shoaling problem exists between the Rogue River jetties, along the inside of the south jetty, and in the turning basin and harbor access channel. ~~(Figure 2)~~. This condition makes maintenance dredging difficult and blocks navigation channels, thus restricting vessel traffic between the ocean and port facilities. Rapid summertime shoaling occurs (when riverflows are normally low) during peak boating and salmon fishing seasons, causing unpredictable and hazardous entrance conditions. Authorized channel dimensions cannot be maintained by dredging due to the rapid shoaling rate. Over 1.8 million dollars were expended on annual maintenance dredging during the period p.7 1962-1976 with a huge backlog of maintenance dredging to be done (Tankersley 1978).*

Purpose of the Model Study

5. At the request of the U. S. Army Engineer District, Portland

* Personal communication, William T. Tankersley to COL Harvey L. Arnold, District Engineer, Portland District, Jan 1978.

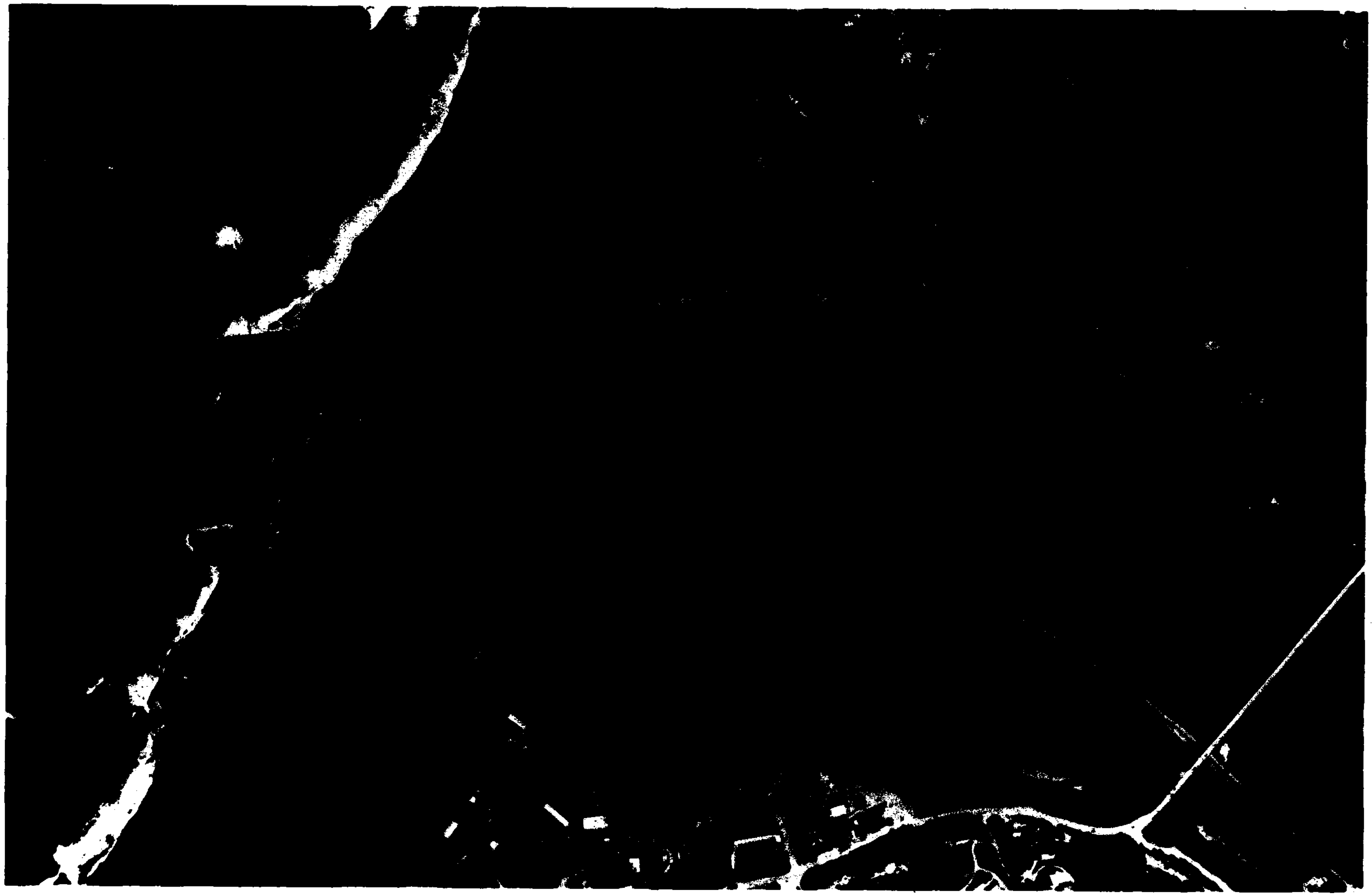

Figure 2. Aerial photograph of Rogue River mouth

(NPP), a hydraulic model investigation was conducted by the U. S. Army Engineer Waterways Experiment Station (WES) to:

a. Study shoaling, wave, current, and riverflow conditions in the lower reaches of the Rogue River for existing conditions and proposed improvements.

b. Develop remedial plans for the alleviation of undesirable conditions as found necessary.

c. Determine if design modification to the proposed plans could be made that would reduce construction costs significantly and still provide adequate shoaling, wave, and flood protection.

cost effective.

PART II: THE MODEL

Design of Model

6. The Rogue River model (Figuré 3) was constructed to an undistorted linear scale of 1:100, model to prototype. Scale selection was based on such factors as:

- a. Depth of water required in the model to prevent excessive bottom friction.
- b. Absolute size of model waves.
- c. Available shelter dimensions and area required for model construction.
- d. Efficiency of model operation.
- e. Available wave-generating and wave-measuring equipment.
- f. Model construction costs.

A geometrically undistorted model was necessary to ensure accurate reproduction of short-period wave and current patterns. Following selection of the linear scale, the model was designed and operated in accordance with Froude's model law (Stevens et al. 1942). The scale relations used for design and operation of the model were as follows:

Characteristic	Dimension*	Model:Prototype Scale Relation
Length	L**	$L_r = 1:100$
Area	L^2	$A_r = L_r^2 = 1:10,000$
Volume	L^3	$V_r = L_r^3 = 1:1,000,000$
Time	T	$T_r = L_r^{1/2} = 1:10$
Velocity	L/T	$V_r = L_r^{1/2} = 1:10$
Roughness (Manning's coefficient, n)	$L^{1/6}$	$n_r = L_r^{1/6} = 1:2.154$
Discharge	L^3/T	$Q_r = L_r^{5/2} = 1:100,000$

* Dimensions are in terms of length and time.
** For convenience, symbols and unusual abbreviations are listed and defined in Appendix A.

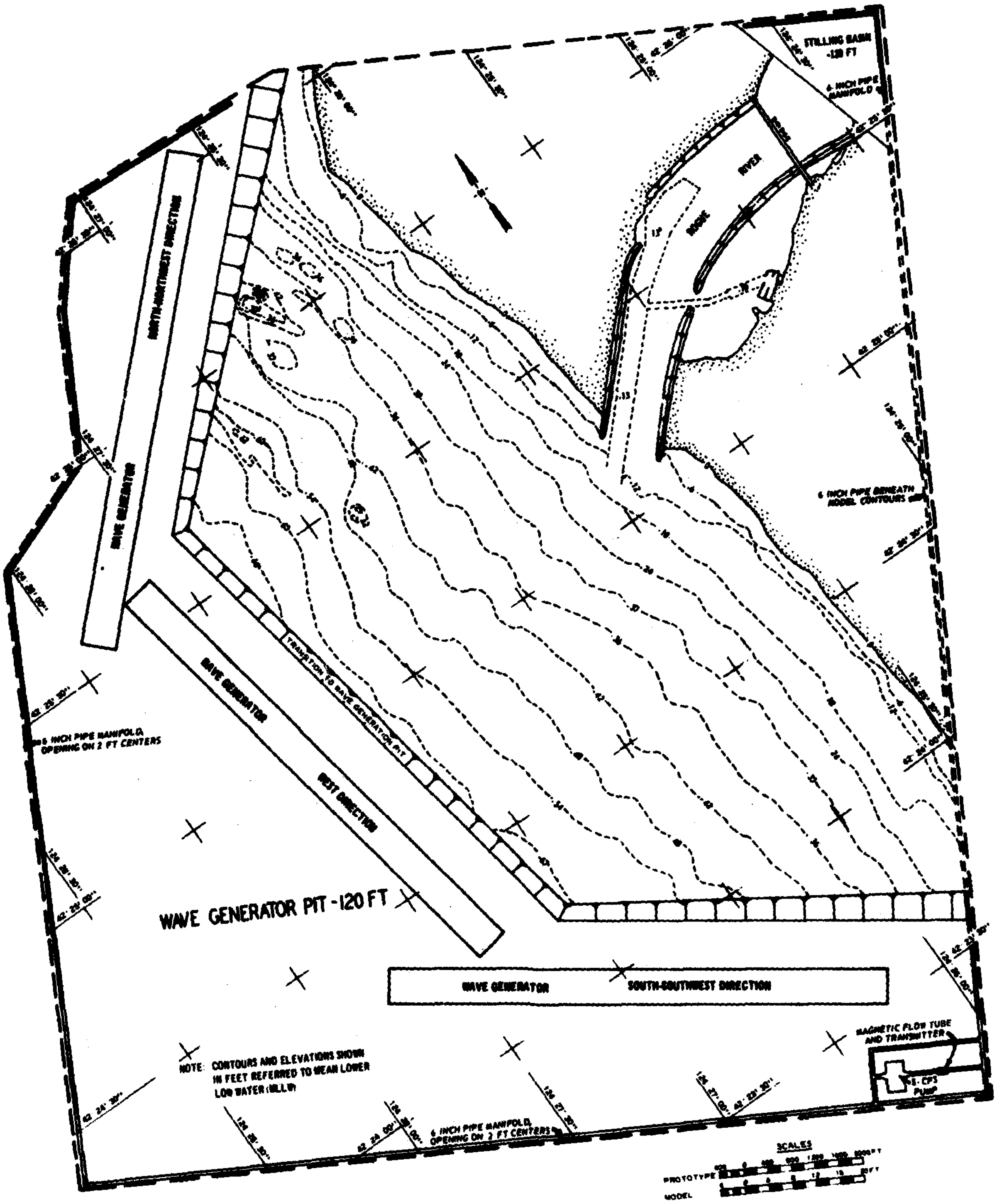

Figure 3. Model layout

7. The proposed improvement plans for Rogue River included the use of rubble-mound jetties and the existing jetties and revetments are also rubble-mound structures. Experience and experimental research have shown that considerable wave energy passes through the interstices of this type of structure; thus, the transmission and absorption of wave energy became a matter of concern in design of the 1:100-scale model. In small-scale hydraulic models, rubble-mound structures reflect relatively more and absorb or dissipate relatively less wave energy than geometrically similar prototype structures (LeMehauté 1965). Also the transmission of wave energy through the breakwater is relatively less for the small-scale model than for the prototype. Consequently, some adjustment in small-scale model rubble-mound structures is needed to ensure satisfactory reproduction of wave-reflection and wave-transmission characteristics. In past investigations (Dai and Jackson 1966, Brasfeild and Ball 1967) at WES, this adjustment was made by determining the wave-energy transmission characteristics of the proposed structure in a two-dimensional model using a scale large enough to ensure negligible scale effects. A breakwater section was then developed for the small-scale, three-dimensional model that would provide essentially the same relative transmission of wave energy. Therefore, from previous findings for breakwaters and wave conditions similar to those at Rogue River, it was determined that a close approximation of the correct wave-energy transmission characteristics would be obtained by increasing the size of the rock used in the 1:100-scale model to approximately two times that required for geometric similarity. Accordingly, in constructing the jetties and revetment structures in the Rogue River model, the rock sizes were computed linearly by scale, then multiplied by 2.0 to arrive at the actual sizes used in the model.

8. The values of Manning's roughness coefficient n used in the design of the main river channel were calculated by NPP from water-surface profiles of known discharges in the prototype. From these computations and experience, an n value of 0.030 was selected for use in the main river channel. In addition, NPP furnished an n value of 0.050 for overbank roughness. Therefore, based on previous WES

investigations and experience (Miller and Peterson 1953, Cox 1973), the various model areas from the entrance to the small-boat basin upstream were given finishes that would represent prototype n values of 0.030 and 0.050.

9. Ideally, a quantitative, three-dimensional, movable-bed model investigation would best determine the effectiveness of various project plans at Rogue River. However, this type of model investigation is difficult and expensive to conduct, and each area in which such an investigation is contemplated must be carefully analyzed. The following computations and prototype data are considered essential for such investigations (Chatham, Davidson, and Whalin 1973):

a. A computation of the littoral transport, based on the best available wave statistics.

b. An analysis of the sand-size distribution over the entire project area (offshore to a point well beyond the breaker zone).

c. Simultaneous measurements of the following items over a period of erosion and accretion of the shoreline (this measurement period should be judiciously chosen to obtain the maximum probability of both erosion and accretion during as short a time span as possible):

   (1) Continuous measurements of the incident-wave characteristics. Such measurements would mean placing enough redundant sensors to accurately estimate the directional spectrum over the entire project area, and in addition, would mean conducting a rather sophisticated analysis of all these data.

   (2) Bottom profiling of the entire project area using the shortest time intervals possible.

   (3) Nearly continuous measurements of both littoral and onshore-offshore transport of sand. These measurements would be especially important over the erosion-accretion period. A wave-forecast service would be essential to this effort to prepare for full operation during the erosion period.

In view of the complexities involved in conducting movable-bed model studies and due to limited funds and time for the Rogue River project, the model was molded in cement mortar (fixed-bed) at an undistorted scale of 1:100 and a tracer material was obtained to determine qualitatively the degree of shoaling at the river mouth for various improvement plans.

The Model and Appurtenances

10. The model reproduced the lower 6,700 ft of the Rogue River, the Rogue River Small-Boat Harbor, approximately 7,000 ft of the Oregon shoreline on each side of the river mouth, and underwater topography in the Pacific Ocean to an offshore depth of 66 ft with a sloping transition to the wave generator pit elevation of -120 ft. The total area reproduced in the model was approximately 26,600 sq ft, representing about 9.5 square miles in the prototype. A general view of the model is shown in Figure 4. Vertical control for model construction was based on mean lower low water datum.* Horizontal control was referenced to a local prototype coordinate system.

11. Model waves were generated by an 80-ft-long piston-type generator. The horizontal movement of the piston plate caused a periodic displacement of water incident to this motion. The length of the stroke and the frequency of the piston plate movement were variable over the range necessary to generate waves with the required characteristics. In addition, the wave generator was mounted on retractable casters which enabled it to be positioned to generate waves from the required directions.

12. A water circulating system (Figure 3), consisting of 6-in. perforated-pipe water-intake and discharge manifolds, a 5-cfs pump, four valves, and a magnetic flow tube and transmitter, was used in the model to reproduce steady-state flows. These flows corresponded to maximum ebb and flood tidal flows or various river discharges. The direction and magnitude of river currents were measured by timing the progress of weighted floats over known distances.

13. An Automated Data Acquisition and Control System (ADACS), designed and constructed at WES (Figure 5), was used to secure wave-height data at selected locations in the model. Basically, through the use of a minicomputer, ADACS recorded onto magnetic tape the electrical output

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* All elevations (el) cited herein are in feet referred to mean lower low water (mllw) unless otherwise defined.

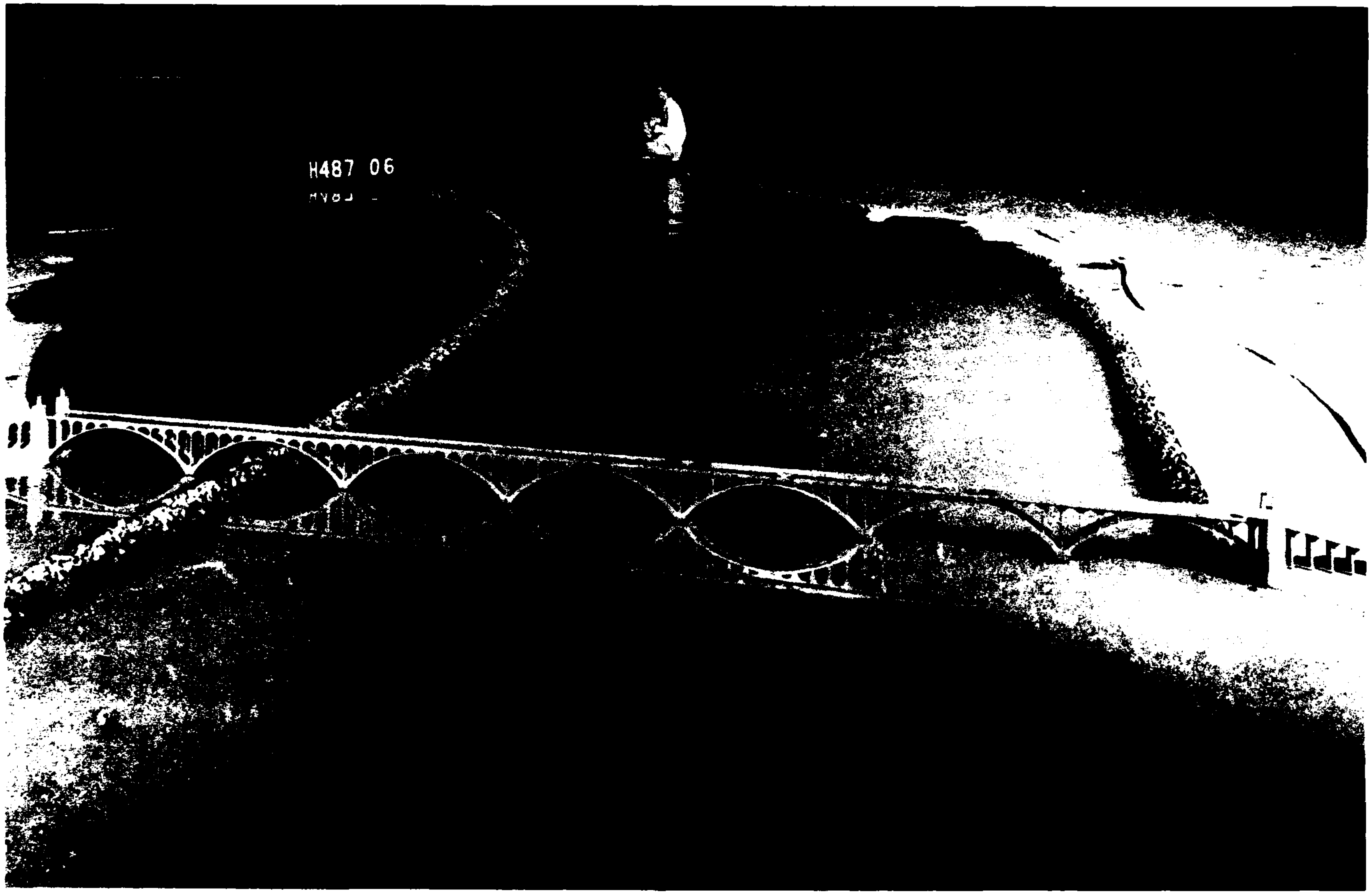

Figure 4. General view of model

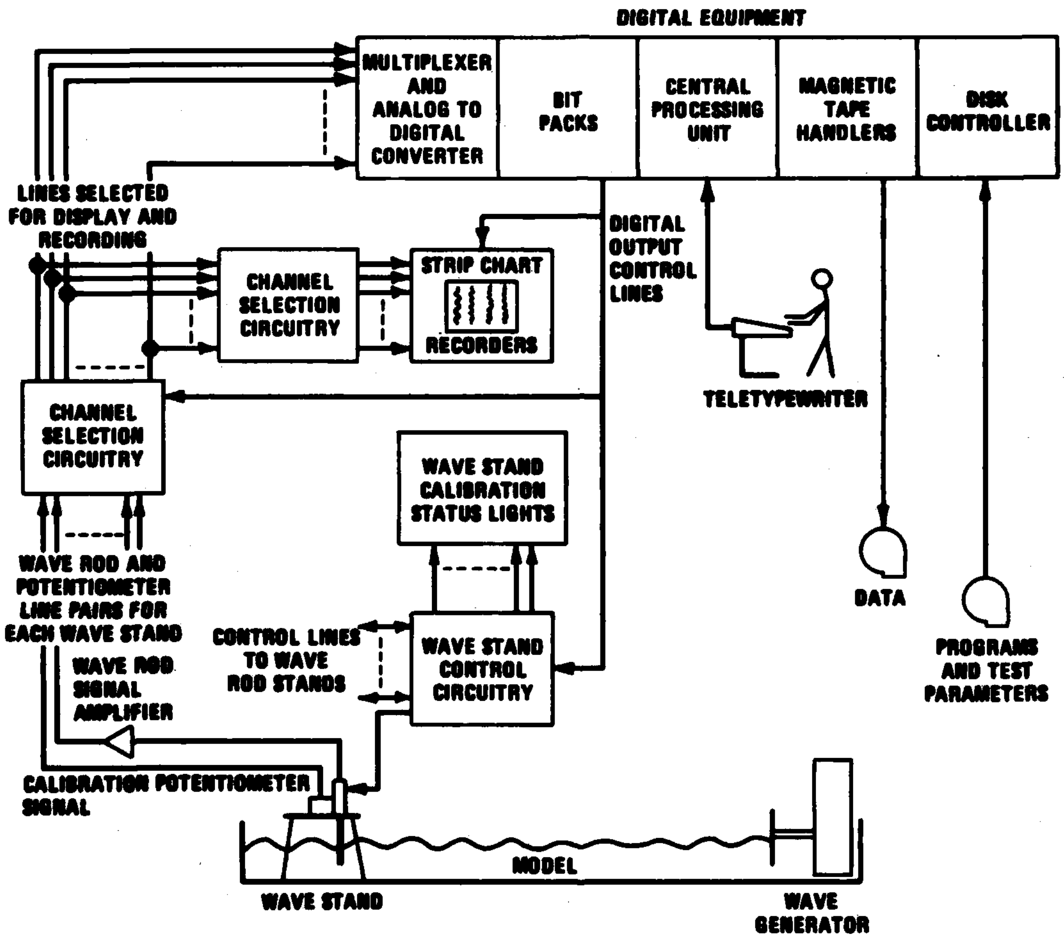

Figure 5. Automated Data Acquisition and Control System (ADACS)

of parallel-wire, resistance-type sensors. These sensors measured the change in water-surface elevation with respect to time. The magnetic tape output was then analyzed to obtain the required data.

14. A 2-ft (horizontal) solid layer of fiber wave absorber was placed around the inside perimeter of the model to damp any wave energy that might otherwise be reflected from the model walls. In addition, guide vanes were placed along the wave generator sides in the flat pit area to ensure proper formation of the wave train incident to the model contours.

Selection of Tracer Material

15. As discussed previously in paragraph 9, a fixed-bed model was constructed and a tracer material selected to determine qualitatively the degree of shoaling at the river entrance for the various improvement plans. As in prior WES investigations (Giles and Chatham 1974, Bottin and Chatham 1975), the tracer was chosen in accordance with the scaling relations of Noda (1972), which indicate a relation or model law among the four basic scale ratios, i.e., the horizontal scale, λ ; the vertical scale, μ ; the sediment size ratio, η_D ; and the relative specific weight ratio, η'_γ (Figure 6). These relations were determined experimentally using a wide range of wave conditions and beach materials and are valid mainly for the breaker zone.

16. Noda's scaling relations indicate that movable-bed models with scales in the vicinity of 1:100 (model to prototype) should be distorted (i.e., they should have different horizontal and vertical scales). Since the fixed-bed model of Rogue River was undistorted to allow accurate reproduction of short-period wave and current patterns, the following procedure was used to select a tracer material. Using the prototype sand characteristics (median diameter, D_{50} = 0.30 - 0.66 mm; specific gravity = 2.76) and assuming the horizontal scale to be in similitude (i.e. 1:100), the median diameter for a given specific gravity of tracer material and the vertical scale were computed. The vertical scale was then assumed to be in similitude and the tracer median diameter

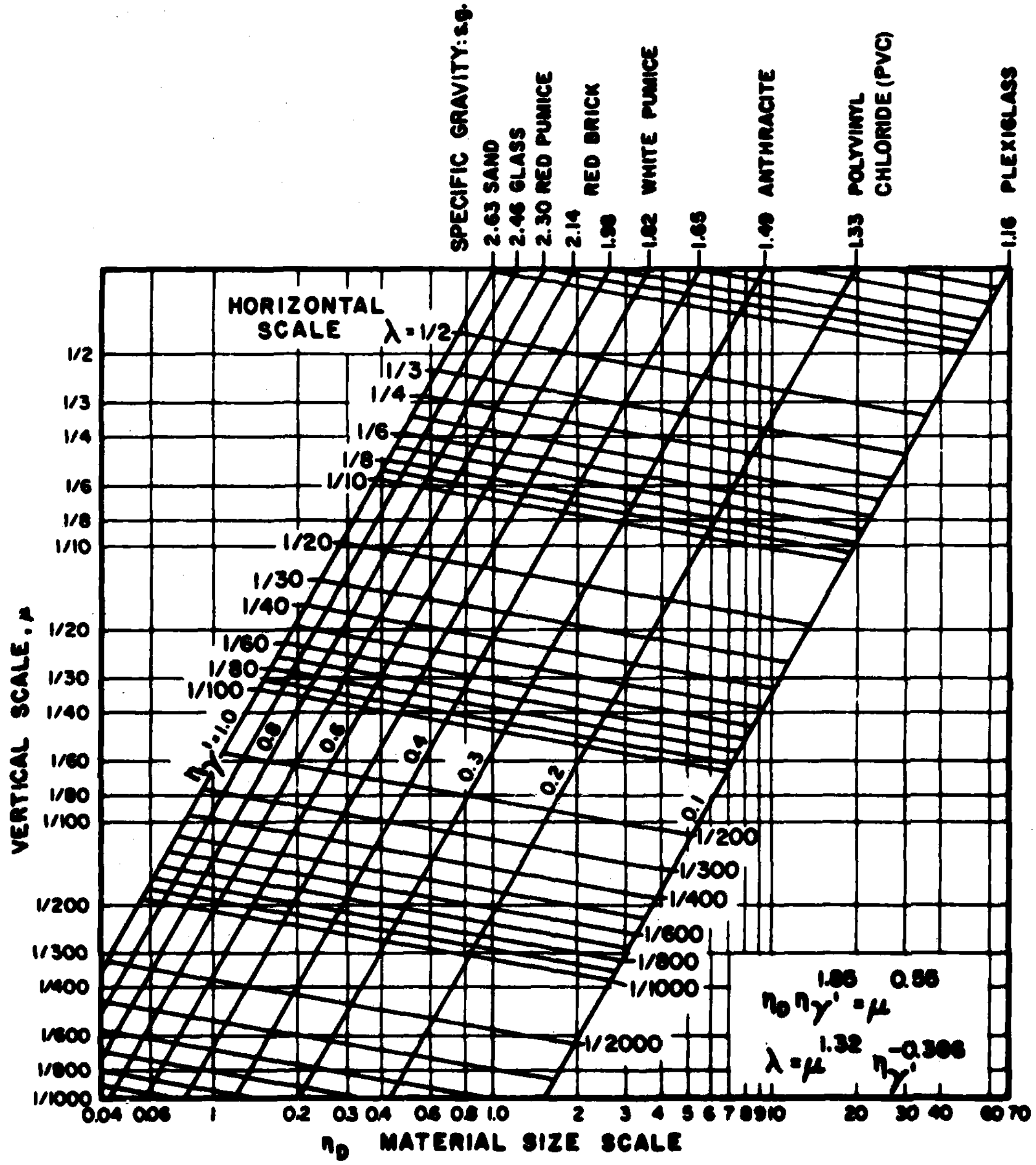

Figure 6. Graphic representation of model law (Noda 1972)

and horizontal scale were computed. This resulted in a range of tracer sizes for given specific gravities that could be used. Although several types of movable-bed tracer materials were available at WES, previous investigations (Giles and Chatham 1974, Bottin and Chatham 1975) indicated that crushed coal tracer more nearly represented the movement of prototype sand at the model scale used for this study. Therefore, quantities of crushed coal (specific gravity = 1.30; median diameter, D_{50} = 0.60-1.80 mm) were selected for use as a tracer material throughout the model investigation.

PART III: TEST CONDITIONS AND PROCEDURES

Selection of Test Conditions

Still-water level

17. Still-water levels (swl's) for wave action models are selected so that the various wave-induced phenomena which are dependent on water depths are accurately reproduced in the model. These phenomena include the refraction of waves in the project area, the overtopping of structures by the waves, the reflection of wave energy from various structures, and the transmission of wave energy through porous structures.

18. It is desirable to select a model swl that closely approximates the higher water stages which normally occur in the prototype for the following reasons:

- a. The maximum amount of wave energy reaching a coastal area normally occurs during the higher water phase of the local tide cycle.
- b. Most storms moving onshore are characteristically accompanied by a higher water level due to wind tide and shoreward mass transport.
- c. The selection of a high swl helps minimize model scale effects due to viscous bottom friction.
- d. When a high swl is selected, a model investigation tends to yield more conservative results.

19. Prototype data obtained at Rogue River during July 1978 by WES personnel indicate that maximum velocities through the lower reaches of the river during the ebb phase of the tidal cycle occur at a tide level of +1.5 ft, and maximum velocities during the flood phase occur at a tide level of +4.3 ft. Therefore, swl's of +1.5 ft and +4.3 ft were selected for model testing of maximum ebb and flood tidal flow conditions. An swl of +6.7 ft representing mean higher high water (mhhw) with no flow was also selected for model tests. In addition, a 0.0 ft swl (mllw) was selected for use in the model during tracer tests.

Factors influencing selection of test wave characteristics

20. In planning the testing program for a model investigation of

wave-action problems, it is necessary to select dimensions and directions for the test waves that will allow a realistic test of proposed improvement plans and an accurate evaluation of the elements of the various proposals. Surface wind waves are generated primarily by the interactions between tangential stresses of wind flowing over water, resonance between the water surface and atmospheric turbulence, and interactions between individual wave components. The height and period of the maximum wave that can be generated by a given storm depend on the wind speed, the length of time that wind of a given speed continues to blow, and the water distance (fetch) over which the wind blows. Selection of test conditions entails evaluation of such factors as:

- a. The fetch and decay distances (the latter being the distance over which waves travel after leaving the generating area) for various directions from which waves can attack the problem area.
- b. The frequency of occurrence and duration of storm winds from the different directions.
- c. The alignment, size, and relative geographic position of the navigation entrance to the harbor.
- d. The alignments, lengths, and locations of various reflecting surfaces in the area.
- e. The refraction of waves caused by differentials in depth in the area seaward of the project location, which may create either a concentration or diffusion of wave energy at the site.

Wave refraction

21. When waves move into water of gradually decreasing depth, transformations take place in all wave characteristics except wave period (to the first order of approximation). The most important transformations with respect to selection of test wave characteristics are the changes in wave height and direction of travel due to the phenomenon referred to as wave refraction. The change in wave height and direction can be determined by plotting refraction diagrams and calculating refraction coefficients. These diagrams are constructed by plotting the position of wave orthogonals (lines drawn perpendicular to wave crests) from deep water into shallow water. If it is assumed that waves do not break and that there is no lateral flow of energy along the wave crest,

the ratio between the wave height in deep water (H_o) and the wave height at any point in shallow water (H) is inversely proportional to the square root of the ratio of the corresponding orthogonal spacings (b_o and b), or $H/H_o = K_s(b_o/b)^{1/2}$. The quantity $(b_o/b)^{1/2}$ is the refraction coefficient, K_r ; K_s is the shoaling coefficient. Thus, the refraction coefficient multiplied by the shoaling coefficient gives a conversion factor for transfer of deepwater wave heights to shallow-water values. The shoaling coefficient, which is a function of wavelength and water depth, can be obtained from CERC (1977).

22. A wave-refraction study for Rogue River was conducted in 1977 for the critical directions of wave approach using computer facilities at WES. From these data the shallow-water wave heights and refracted wave directions at the transition to the model contours were determined. This analysis was conducted using a linear wave-refraction theory originally developed at Stanford University by Dobson (1967) and modified by WES in 1971. In this analysis, the effects of both reflection and diffraction are neglected. These assumptions are valid except in convergence areas where caustics occur and linear theory does not apply. Therefore, the major assumption in determining the wave height at any point on a wave orthogonal, within the limits of the linear theory, is that no energy is transmitted perpendicular to the orthogonal along the wave crest. This assumption has been shown to be reasonable for mild slopes that induce only gradual bending of the orthogonals. For areas of extreme refraction, failure to consider the flow of energy along the wave crests can lead to significant errors in the computed wave height. Since previous research at WES by Whalin (1971, 1972) has shown that wave energy will tend to flow along the wave crests in areas of energy concentration, a maximum refraction coefficient of 1.4 and a minimum refraction coefficient of 0.35 were selected as being reasonable values.

23. Refraction and shoaling coefficients and shallow-water orthogonal directions obtained for various wave periods from nine deepwater wave directions (north counterclockwise through south) are presented in Table 1. These values represent an average of the orthogonals in the immediate vicinity of the Rogue River site (approximately the location

of the wave generator in the model). Shoaling coefficients of 1.00, 0.99, 0.95, 0.92, 0.91, 0.93, 0.95, and 0.98 for 5-, 7-, 9-, 11-, 13-, 15-, 17-, and 19-sec wave periods, respectively, were computed for a 120-ft water depth corresponding to the simulated depth at the model wave generator. The wave-height adjustment factor is obtained by multiplying K_r times K_s and can be applied to any deepwater wave height to obtain the corresponding shallow-water value. Based on the refracted directions secured at the model contours for each wave period, the following test directions (deepwater direction and corresponding shallow-water direction) were selected for use during model testing.

Deepwater Direction deg	Selected Shallow-Water Test Direction, deg
NNW, 337.5	318
West, 270	263
SW, 225	233
SSW, 202.5	218

Prototype wave data and selection of test waves

24. Measured prototype wave data on which a comprehensive statistical analysis of wave conditions could be based were unavailable for the Rogue River area. However, deepwater wave hindcast data for this area were obtained from the following:

a. National Marine Consultants (1960) for station 1 (located approximately on the Oregon-California border). These data represent the estimated durations and magnitudes of deepwater waves (sea and swell) approaching Rogue River from the various directions.

b. Surface Marine Observations (National Climatic Center 1976). These data represent an analysis of shipboard observations that provide good coverage of all synoptic events of importance to the Rogue River area.

c. Fleet Numerical Weather Center (April 1969-December 1977). These data represent daily hindcasts in the area (stations 44N, 127W and 41N, 127W), computed by the Department of the Navy.

Deepwater data from a, b, and c above are summarized in Tables 2-4,

respectively. These data were converted to shallow-water values by application of refraction and shoaling coefficients and are shown in Tables 5-7. Characteristics of test waves used in the model (selected from Tables 5-7) are shown in the following tabulation.

Deepwater	Selected Test Waves	
Direction	Period, sec	Height, ft
North-northwest	5	7, 12*
	7	7, 12, 20*
	9	7, 12, 17, 27
	11	7, 12, 19
	13	7, 13, 21
	15	7, 11, 17
	17	7, 11
West	5	7, 12*
	7	7, 12, 20*
	9	7, 12, 23, 31
	11	7, 12, 23, 31
	13	7, 12, 21, 29
	15	7, 12, 21, 29
	17	7, 12, 17
Southwest	5	7, 12*
	7	7, 12, 20*
	9	7, 13, 21, 27
	11	7, 13, 21, 29
	13	7, 13, 21, 27
	15	7, 12, 17, 25
	17	7, 12, 18
South-southwest	5	7, 12*
	7	7, 12, 20*
	9	7, 12, 17, 27
	11	7, 12, 17, 27
	13	7, 12, 21
	15	7, 12, 23
	17	7, 12, 18

* Steepness limited waves.

Tidal flows and velocities

25. Prototype data obtained at Rogue River by WES personnel during July 1978 were examined and tidal velocities through the lower reaches of the river ranging from 0.85 to 1.25 fps and 1.0 to 1.1 fps were selected as being representative of maximum ebb and flood flow conditions, respectively.

River discharges

26. Typically, during the December through March months, the Rogue River discharges a daily high flow of 20,000 to 30,000 cfs with the base peak discharge set at 35,000 cfs (Hartman 1977). During the summer months, normally lower summer runoff stages of only about 500 cfs occur. Major floods in Rogue River occur when warm, heavy rains follow a cold period that has deposited snow over much of the basin. Runoff during such floods occurs rapidly and the floods normally have a 2- to 4-day duration. Spring freshets resulting from normal snowmelt are of longer duration; however, peak discharges are generally not high enough to cause damage. The greatest flood of record occurred in December 1964. It had an estimated discharge of 500,000 cfs and a recurrence interval of approximately 100 years. Peak stages downstream of the highway bridge were 19 to 20 ft above mllw.

27. Maximum river discharges that could be reproduced in the model were about 350,000 cfs due to jet effects at the entrance (requiring a larger ocean area).

Analysis of Model Data

28. Relative merits of the various plans were evaluated by:

a. Comparison of tracer movement and subsequent deposits.

b. Comparison of water-surface profiles and river current velocities.

c. Comparison of wave-induced current patterns and magnitudes.

d. Comparisons of wave heights at selected locations in the model.

e. Visual observations and wave pattern photographs.

In analyzing the wave-height data, the average height of the highest one-third of the waves recorded at each gage location was selected. All wave heights thus selected were adjusted to compensate for wave-height attenuation due to viscous bottom friction in the model by application of Keulegan's equation (Keulegan 1950). From this equation, reduction of wave heights in the model can be calculated as a function

of water depth, width of wave front, wave period, water viscosity, and distance of wave travel. Wave-induced current magnitudes were obtained by timing the progress of an injected dye tracer relative to a thin graduated scale placed on the model floor and river current velocities were secured by timing a weighted float over a known distance in the river channel. Water-surface profiles for various river discharges were determined by recording elevation changes on point gages located at various stations in the river.

PART IV: TESTS AND RESULTS

The Tests

Base tests

29. Prior to tests of the various improvement plans, comprehensive tests were conducted for existing conditions (Base Test 1 and Base Test 2). Base Test 1 (Plate 1) represented existing conditions with a shoal in the river mouth. This shoal was an average condition based on evaluations of detailed soundings in the mouth of the Rogue River (soundings furnished by NPP covering the period May 1976-September 1979). Base Test 2 (Plate 2) entailed the removal of the shoal and represented existing conditions following a flood or a scoured channel condition. Wave-height data were obtained for Base Test 1 and Base Test 2 at various locations throughout the lower reaches of the river and the small-boat harbor for selected test waves and directions listed in paragraph 24. Wave-induced current patterns and magnitudes, shoaling patterns, and wave pattern photographs also were secured for representative waves from the four selected test directions. In addition, water-surface elevations and river current velocities were obtained for both Base Test 1 and Base Test 2.

Improvement plans

30. Model tests were conducted for 58 variations in the design elements of three basic remedial improvement plans. Dikes installed within the existing entrance, extensions of the existing jetties, and an alternate harbor entrance were tested with variations consisting of changes in the lengths, alignments, and/or cross sections of the various structures. Tracer tests, wave-height tests, wave-induced current patterns and magnitudes, wave patterns, water-surface elevations, river current velocities, and/or long-term shoaling tests were conducted for various improvement plans. Brief descriptions of the test plans are presented in the following subparagraphs; dimensional details are presented in Plates 3-19.

Dikes installed within the existing entrance:

a. Plan 1 (Plate 3) consisted of a 570-ft-long timber-pile dike extending northwesterly from the south jetty at a point downstream of the small-boat basin entrance. This dike was composed of three rows of 1-ft-diameter pilings installed at an elevation of +8 ft. The pilings in each row were placed 5 ft apart with the center line of the rows installed 2-1/2 ft apart. The center row was offset by 2-1/2 ft.

b. Plan 1A (Plate 3) entailed the timber-pile dike of Plan 1 with a blanket of 800-lb stone placed to a thickness of 5 ft on each side of the dike.

c. Plan 1B (Plate 3) involved the elements of Plan 1A with 800-lb stone placed at an elevation of +8 ft on each side of the dike for a 200-ft distance starting at the south jetty and extending northwesterly.

d. Plan 2 (Plate 4) consisted of two rubble-mound dikes installed perpendicular to the south jetty at crest elevations of +10 ft. One dike was 450 ft long and the other was 570 ft long.

e. Plan 2A (Plate 5) consisted of three 400-ft-long rubble-mound dikes installed perpendicular to the south jetty at +10 ft crest elevations.

f. Plan 3 (Plate 6) entailed the elements of Plan 2A with an 800-ft-long weir section installed in the existing north jetty at an elevation of +8 ft and a 275-ft-wide conveyance channel installed at an elevation of +5 ft.

g. Plan 3A (Plate 6) involved the elements of Plan 3 but the weir section was installed at an elevation of +5 ft.

h. Plan 3B (Plate 7) encompassed the +5 ft weir section and conveyance channel elevations of Plan 3A and the 450-ft-long and 570-ft-long rubble-mound dikes of Plan 2.

Jetty extensions (existing alignment):

i. Plan 4 (Plate 8) consisted of a 1,950-ft-long extension of the north jetty on the same alignment as the existing jetty.

j. Plan 4A (Plate 8) consisted of a 1,950-ft-long extension of the north jetty but the seaward 600-ft section was oriented 45 deg to the north of the original alignment.

k. Plan 4B (Plate 8) entailed a 1,350-ft-long extension of

the north jetty with the seaward 600-ft section oriented 45 deg to the north of the existing jetty alignment.

l. Plan 4C (Plate 9) involved a 1,350-ft-long extension of the north jetty on the original alignment. At a point 550 ft seaward of where the new jetty extension originated, a 600-ft-long spur was installed at an angle of 45 deg to the north of the original alignment.

m. Plan 4D (Plate 9) entailed the elements of Plan 4C with the spur length decreased by 200 ft to a total length of 400 ft.

n. Plan 4E (Plate 9) consisted of the elements of Plan 4C with the spur length decreased by 100 ft to a total length of 500 ft.

o. Plan 4F (Plate 9) involved the elements of Plan 4D with 200 ft of the north jetty extension removed resulting in an 1,150-ft-long north jetty extension with a 400-ft-long spur.

p. Plan 4G (Plate 9) entailed the 1,150-ft-long jetty extension of Plan 4F with the spur length increased by 200 ft to its original 600-ft length.

q. Plan 5 (Plate 10) consisted of the 1,350-ft-long jetty extension and 500-ft-long spur of Plan 4E with an 1,100-ft-long extension of the south jetty.

r. Plan 5A (Plate 10) involved the elements of Plan 5 with a 300-ft-long spur installed on the south jetty. This spur was installed at an angle of 45 deg to the south of the original alignment and began at a point 600 ft seaward of where the jetty extension originated.

s. Plan 5B (Plate 10) entailed the elements of Plan 5A with the south jetty length increased by 200 ft resulting in a 1,300-ft-long south jetty extension with a 300-ft-long spur.

t. Plan 5C (Plate 10) consisted of the elements of Plan 5B with the spur length increased by 100 ft to a total length of 400 ft.

u. Plan 5D (Plate 10) entailed the elements of Plan 5C with 200 ft of the south jetty extension removed resulting in an 1,100-ft-long south jetty extension with a 400-ft-long spur.

v. Plan 5E (Plate 10) involved the elements of Plan 5D with the south jetty length increased by 100 ft resulting in a 1,200-ft-long south jetty extension with a 400-ft-long spur.

Jetty extensions (toward the west):

w. Plan 6 (Plate 11) consisted of a 1,360-ft-long north jetty extension and an 1,810-ft-long south jetty extension oriented toward the west (on an azimuth of S 81°41'30" W).

x. Plan 6A (Plate 11) involved the elements of Plan 6 with a 200-ft-long spur installed on the south jetty extension. This spur was installed at an angle of 90 deg to the south of the jetty extension alignment and began at a point 400 ft seaward of where the jetty extension originated.

y. Plan 6B (Plate 11) entailed the elements of Plan 6A with the spur length increased by 100 ft to a total length of 300 ft.

z. Plan 6C (Plate 11) consisted of the 1,810-ft-long south jetty extension and 300-ft-long spur of Plan 6B; but the spur was moved shoreward 200 ft and thus began at a point 200 ft seaward of where the jetty extension originated.

aa. Plan 6D (Plate 11) entailed the elements of Plan 6C with the south jetty length decreased by 200 ft resulting in a 1,610-ft-long south jetty extension with a 300-ft-long spur.

bb. Plan 7 (Plate 12) consisted of the 1,610-ft-long south jetty extension and 300-ft-long spur of Plan 6D with the north jetty extension length decreased by 200 ft resulting in an 1,160-ft-long north jetty extension.

cc. Plan 7A (Plate 12) involved the elements of Plan 7 with a 400-ft-long spur installed on the north jetty extension at an angle of 45 deg to the north of the jetty extension alignment and beginning at a point 600 ft seaward of where the jetty extension originated. This plan resulted in a 1,610-ft-long south jetty extension with a 300-ft-long spur and an 1,160-ft-long north jetty extension with a 400-ft-long spur.

dd. Plan 7B (Plate 12) entailed the elements of Plan 7A with the north jetty extension length increased by 200 ft resulting in a 1,360-ft-long jetty extension with a 400-ft-long spur.

ee. Plan 7C (Plate 13) consisted of the elements of Plan 7B; but the spur was moved seaward 200 ft and thus began at a point 800 ft seaward of where the north jetty extension originated. The south and north jetties were 1,610 and 1,360 ft long, respectively, with spur lengths of 300 and 400 ft, respectively.

ff. Plan 7D (Plate 13) involved the elements of Plan 7C with the north jetty extension length increased by 200 ft resulting in a 1,560-ft-long north jetty extension with a 400-ft-long spur.

gg. Plan 7E (Plate 13) entailed the elements of Plan 7D with the spur length increased by 200 ft to a total length of 600 ft. This plan resulted in a 1,610-ft-long south jetty with a 300-ft-long spur and a 1,560-ft-long north jetty with a 600-ft-long spur.

hh. Plan 7F (Plate 13) consisted of the elements of Plan 7E; but the spur was moved shoreward 200 ft and thus began at a point 600 ft seaward of where the north jetty extension originated.

ii. Plan 7G (Plate 14) entailed the 1,610-ft-long south jetty extension and 300-ft-long spur of Plan 6D with a 1,560-ft-long north jetty extension. The seaward 400 ft of the north extension was oriented at an angle of 45 deg to the north of the original alignment.

jj. Plan 7H (Plate 14) involved the elements of Plan 7G but the seaward 600 ft of the north jetty extension was oriented at an angle of 45 deg to the north of the original alignment.

kk. Plan 7I (Plate 15) consisted of the 1,610-ft-long south jetty extension and 300-ft-long spur of Plan 6D with a 1,760-ft-long north jetty extension. The seaward 400 ft of the north extension was oriented at an angle of 45 deg to the north of the original alignment.

ll. Plan 7J (Plate 15) entailed the 1,610-ft-long south jetty extension and 300-ft-long spur of Plan 6D with the seaward angled portion of the north jetty extension increased by 200 ft in length resulting in a total north jetty extension length of 1,960 ft. Of this 1,960-ft-long north jetty extension, 1,360-ft was installed on the S81°41'30" W alignment and 600 ft was oriented 45 deg to the north of this alignment.

Jetty extensions (toward the south):

mm. Plan 8 (Plate 16) consisted of an 1,150-ft-long south jetty extension installed on an azimuth of S 16°23'22" W and a 2,450-ft-long north jetty extension. The shoreward 550 ft of the north extension was installed on the same alignment as the existing jetty and the seaward 1,900 ft was oriented parallel to the south jetty extension (on an azimuth of S 16°23'22" W).

nn. Plan 8A (Plate 16) entailed the 1,150-ft-long and 2,450-ft-long south and north jetty extensions, respectively, of Plan 8 with a 200-ft-long spur installed on the south jetty extension. This spur was installed at an angle of 45 deg to the south of the jetty extension alignment and began at a point 550 ft seaward of where the jetty extension originated.

oo. Plan 8B (Plate 16) involved the elements of Plan 8A with the spur length increased by 100 ft to a total length of 300 ft on the south jetty extension.

pp. Plan 8C (Plate 16) consisted of the elements of Plan 8 with an additional 200-ft length installed on the seaward end of the south jetty extension at an angle of 45 deg to the south of the original alignment. This resulted in a total south jetty extension length of 1,350 ft. The north jetty extension remained 1,150 ft in length.

qq. Plan 8D (Plate 16) entailed the elements of Plan 8 with the seaward 200 ft of the south jetty extension oriented at an angle of 45 deg to the south of the original alignment. The total lengths of the south and north jetty extensions were 1,150 ft and 2,450 ft, respectively.

rr. Plan 9 (Plate 16) involved the elements of Plan 8D but the seaward 200 ft of the north jetty extension was oriented at an angle of 45 deg to the south of the original alignment parallel to the seaward 200 ft of the south jetty extension.

Alternate harbor entrance:

ss. Plan 10 (Plate 17) consisted of an 1,150-ft-long south jetty extension; a new 3,200-ft-long jetty installed approximately 700 ft south of the existing south jetty; and a 300-ft-wide, 13-ft-deep entrance channel extending from the -13 ft contour in the Pacific Ocean easterly to the small-boat basin. The area between these jetties, other than the entrance channel, was dredged to -6 ft and the existing small-boat harbor entrance was closed.

tt. Plan 10A (Plate 17) involved the elements of Plan 10 but the seaward 200 ft of the new south jetty was oriented 45 deg to the south of its original alignment.

uu. Plan 10B (Plate 17) entailed the elements of Plan 10A with the seaward angled portion of the new south jetty increased by 200 ft in length resulting in a total south jetty length of 3,400 ft. The old south jetty (middle jetty) remained 1,150 ft in length.

vv. Plan 10C (Plate 17) consisted of the elements of Plan 10A but the seaward angled portion of the new south jetty was increased in length by 400 ft resulting in a total south jetty length of 3,600 ft. The middle jetty length remained at 1,150 ft.

ww. Plan 10D (Plate 17) entailed the elements of Plan 10 with a 200-ft extension installed on the seaward end of the new south jetty and oriented 45 deg to the south of the original alignment. This extension resulted in a total south jetty length of 3,400 ft. The middle jetty length remained at 1,150 ft.

xx. Plan 10E (Plate 17) involved the elements of Plan 10D with an additional 200 ft of structure length installed on the seaward angled portion of the new south jetty resulting in a total south jetty length of 3,600 ft.

yy. Plan 10F (Plate 18) consisted of the elements of Plan 10 with a 400-ft extension of the new south jetty. This extension entailed 200 ft of structure installed on the same alignment as the south jetty and the seaward 200 ft installed 45 deg to the south of the original alignment and resulted in a 3,600-ft-long total south jetty length. The middle jetty length remained at 1,150 ft.

zz. Plan 10G (Plate 18) involved the elements of Plan 10F with a 200-ft extension installed on the seaward angled portion of the new south jetty resulting in a total south jetty length of 3,800 ft.

aaa. Plan 10H (Plate 18) entailed the 1,150-ft-long middle jetty extension and the 3,200-ft-long new south jetty extension of Plan 10 with a 300-ft-long spur installed on the new south jetty. This spur was oriented 45 deg south of the jetty alignment and began at a point 700 ft shoreward of the seaward end of the new south jetty.

bbb. Plan 10I (Plate 18) consisted of the 1,150-ft-long and 3,200-ft-long extensions of the middle and new south jetties, respectively, of Plan 10 with a 200-ft-long spur installed on the new south jetty at an angle of 45 deg to the south of the jetty alignment. This spur originated at a point 500 ft shoreward of the seaward end of the new south jetty.

ccc. Plan 10J (Plate 18) involved the elements of Plan 10I with the spur length increased by 100 ft to a total length of 300 ft. This resulted in a middle jetty length of 1,150 ft and a new south jetty length of 3,200 ft with a 300-ft-long spur.

ddd. Plan 11 (Plate 19) consisted of the elements of Plan 10J with a 300-ft extension of the middle (existing south

jetty) jetty. This resulted in a 1,450-ft-long middle jetty.

eee. Plan 11A (Plate 19) entailed the elements of Plan 11 with an additional 300-ft extension of the middle jetty oriented 45 deg to the south of the original alignment. This resulted in a 1,750-ft-long middle jetty length.

fff. Plan 11B (Plate 19) involved the elements of Plan 11A with an additional 200-ft extension installed on the seaward angled portion of the middle jetty. This plan entailed a 1,950-ft-long middle jetty, and a 3,200-ft-long new south jetty with a 300-ft-long spur attached.

Wave-height tests

31. Wave-height tests were limited to only the most promising improvement plan (Plan 11B) using test waves from southwest and south-southwest. Wave gage locations are shown in Plate 19.

Wave-induced current pattern and magnitude tests

32. Wave-induced current patterns and magnitudes were determined at selected locations by timing the progress of a dye tracer relative to a known distance on the model surface. These tests were conducted for selected improvement plans using representative test waves from one or more of the four test directions.

Tracer tests

33. Tracer tests were conducted for most of the improvement plans using representative test waves for various test directions. Tests involving certain proposed test plans were limited to test waves from the most critical direction with respect to shoaling in the river entrance (i.e., NNW and SSW). The best improvement plans were subjected to more comprehensive testing. Tracer material was introduced into the model south of the south jetty and north of the north jetty to represent sediment from those shorelines, respectively. In addition, tracer was introduced seaward of the river mouth to represent sediment washed out of the river and deposited by various discharges.

34. Long-term shoaling tests were conducted at the river mouth for the major improvement plans. These tests were conducted by slowly introducing tracer material into the model between the jetties for test

waves from west and/or southwest in conjunction with a +4.3 ft swl (maximum flood tidal flow) or a 0.0-ft swl (no flow) until the material accumulated and formed a shoal. These tests were conducted assuming that an unlimited supply of sediment was available at the river entrance and were run long enough to ensure maximum penetration of the shoal upstream.

River current velocity and
water-surface elevation tests

35. River current velocity measurements and water-surface profiles for various plans of improvement were secured at various stations in the lower reaches of the river for river discharges of 50,000, 100,000, 150,000, 200,000, 250,000, 300,000, and 350,000 cfs using the 0.0 and +6.7 ft swl's. Stations from the entrance to the eastern end of the 13-ft-deep turning basin were located along the center line of the maintained channel and turning basin. Stations upstream of the turning basin were located along the center line of the river.

Test Results

36. In evaluating test results, the relative merits of various plans were based on the movement of tracer material and subsequent deposits, measured wave heights, wave-induced current patterns and magnitudes, water-surface elevations and/or river current velocities, or a combination of the preceding. Model wave heights (significant wave height or $H_{1/3}$), water-surface elevations, and river current velocities were tabulated to show measured values at selected locations. Water-surface elevations also were plotted graphically to show water-surface profiles along the center line of the river and channel. Wave-induced current patterns and magnitudes were superimposed on wave pattern photographs for the corresponding plan and wave condition tested. The general movement of tracer material and subsequent deposits were shown in photographs. Arrows were superimposed onto these photographs to depict sediment movement.

Base tests

37. Wave-height measurements obtained for Base Test 1 using the +6.7 ft swl are presented in Tables 8 and 9. Maximum wave heights obtained were 14.8 ft in the entrance at the seaward end of the jetties (gage 3) for 17-sec, 7-ft test waves from NNW; 1.7 ft along the revetment on the north bank (gage 9) for 7-sec, 12-ft test waves from SW; 1.3-ft upstream of the U. S. 101 Highway Bridge (gage 10) for 13-sec, 21-ft test waves from SW; 3.3 ft in the entrance to the small-boat basin (gage 12) for 15-sec, 25-ft test waves from SW; and 0.6 ft inside the small-boat basin (gage 15) for 17-sec, 25-ft test waves from west.

38. Wave-height tests conducted for Base Test 1 using the +1.5 ft (for maximum ebb tidal flow) and +4.3 ft (for maximum flood tidal flow) swl's for test waves from SW are presented in Table 10. Maximum wave heights were 12.1 and 11.5 ft in the entrance at the seaward end of the jetties; 0.3 and 0.6 ft along the revetment on the north bank; 0.2 and 0.5 ft upstream of the U. S. 101 Highway Bridge; 0.5 and 1.7 ft in the entrance to the small-boat basin; and 0.2 and 0.4 ft inside the small-boat basin for the +1.5 and +4.3 ft swl's, respectively.

39. Wave-induced current patterns and magnitudes secured for Base Test 1 for maximum ebb (+1.5 ft swl) and maximum flood (+4.3 ft swl) flow conditions and the +6.7 ft swl (no flow) for representative test waves from all four directions are shown in Photos 1-41. Maximum velocities obtained at various locations were as follows:

Location	Maximum Velocity, fps	swl	Direction	Test Wave
Shoreline south of south jetty	5.9	+6.7	SW	7 sec, 12 ft
Area seaward of entrance	10.0	+4.3	NNW	9 sec, 27 ft
	10.0	+4.3	NNW	11 sec, 12 ft
Area over shoal	9.1	+1.5	NNW	11 sec, 12 ft
	9.1	+4.3	NNW	11 sec, 12 ft
Channel	5.6	+1.5	W	9 sec, 23 ft
	5.6	+1.5	W	13 sec, 7 ft
Shoreline north of north jetty	9.1	+4.3	SSW	11 sec, 12 ft

Typical wave patterns for Base Test 1 also are shown in Photos 1-41.

40. The general movement of tracer material and subsequent deposits obtained for Base Test 1 for represesentative test waves from all four directions using the 0.0, +1.5 (maximum ebb), +4.3 (maximum flood), and +6.7 ft swl's are shown in Photos 43-90. Photo 42 shows the deposition of sediment from the river for a 100,000-cfs discharge for Base Test 1. For test waves from NNW, tracer movement was from north to south. Tracer on the north shoreline migrated around the head of the north jetty. Some of the material moved across the entrance, some deposited in the channel, and some migrated to and deposited along the inside of the south jetty. For maximum flood tidal flow conditions, tracer material penetrated between the jetties and over the fixed-bed shoal. For test waves from west, tracer material along the north and south shorelines did not present a major shoaling problem; however, tracer seaward of the entrance (representing sediment washed out of the river by various discharges) moved into the entrance inside the south jetty. Test waves from SW moved material from south to north. Tracer material on the south shoreline migrated around the head of the south jetty. Some of the material moved across the entrance and some along the inside of the south jetty. The +4.3 ft swl (maximum flood tidal conditions) resulted in the deepest penetration of tracer material into the channel. Tracer material penetrated between the jetties and over the fixed-bed shoal for several of the test waves. For test waves from SSW, the movement of tracer was from south to north. Again some of the material moved across the channel, some along the inside of the south jetty, and some deposited in the channel. For maximum flood tidal flow conditions, tracer penetrated well within the jetties over the fixed-bed shoal and into the channel.

41. Results of water-surface elevation and depth-averaged river current velocity measurements for Base Test 1 are shown in Tables 11 and 12 for the 0.0 and +6.7 ft swl's. Water-surface profiles were plotted from the data in Table 11 and are shown in Plates 20 and 21. Velocities between the jetties at the entrance ranged from 5.7 fps for the 50,000-cfs river discharge to 33.3 fps for the 350,000-cfs discharge

with the 0.0-ft swl. For the +6.7 ft swl, velocities between the jetties at the entrance ranged from 3.1 to 23.0 fps for the 50,000- and 350,000-cfs discharges, respectively. These tests reveal water-surface elevations and river current velocities that could be expected during periods when the shoal was present in the entrance prior to any significant erosion. Particularly at the higher discharges, the shoal should erode quickly in the prototype, substantially reducing current velocities. Therefore, the upper values obtained in the tests described above are not considered realistic.

42. Results of wave-height tests obtained for Base Test 2 using the +6.7 ft swl are presented in Tables 13 and 14. Maximum wave heights secured were 17.0 ft in the entrance at the seaward end of the jetties (gage 3) for 13-sec, 27-ft test waves from SW; 5.5 ft along the revetment on the north bank (gage 9) for 7-sec, 12-ft test waves from SW; 3.7 ft upstream of the U. S. 101 Highway Bridge (gage 10) for 13-sec, 21-ft test waves from SW; 2.2 ft in the entrance to the small-boat basin (gage 12) for 15-sec, 12-ft test waves from SW; and 0.7 ft inside the small-boat basin (gage 13) for 17-sec, 18-ft test waves from SW.

43. Wave-height tests conducted for Base Test 2 using the +1.5 ft (for maximum ebb tidal flow) and +4.3 ft (for maximum flood tidal flow) swl's for test waves from SW are presented in Table 15. Maximum wave heights were 12.8 and 13.2 ft in the entrance at the seaward end of the jetties; 2.8 and 2.9 ft along the revetment on the north bank; 1.7 and 2.4 ft upstream of the U. S. 101 Highway Bridge; 1.2 and 2.2 ft in the entrance to the small-boat basin; and 0.2 and 0.5 ft inside the small-boat basin for the +1.5 and +4.3 ft swl's, respectively.

44. Wave-induced current patterns and magnitudes were obtained for Base Test 2 for maximum ebb (+1.5 ft swl) and maximum flood (+4.3 ft swl) flow conditions and the +6.7 ft swl (no flow) for representative test waves from the four directions and are shown in Photos 91-132. Maximum velocities obtained at various locations were as follows:

Location	Maximum Velocity, fps	swl	Direction	Test Wave
Shoreline south of south jetty	4.8 4.8	+6.7 +6.7	SW SW	11 sec, 13 ft 17 sec, 7 ft
Area seaward of entrance	12.5	+6.7	NNW	11 sec, 12 ft
Area between jetties south of channel	7.1	+4.3	NNW	11 sec, 12 ft
Channel	5.3	+4.3	SW	7 sec, 12 ft
Shoreline north of north jetty	10.0	+4.3	SSW	11 sec, 12 ft

Typical wave patterns for Base Test 2 also are shown in Photos 91-132.

45. Tracer tests were conducted for Base Test 2 for representative test waves from the four test directions using the 0.0, +1.5 (maximum ebb), +4.3 (maximum flood), and +6.7 ft swl's. The general movement of tracer and subsequent deposits for these tests are shown in Photos 133-180. For test waves from NNW, tracer movement was from north to south. Tracer on the north shoreline migrated around the head of the north jetty where some of the material moved across the entrance, some deposited in the channel, and some migrated to and deposited along the inside of the south jetty. For test waves from west, tracer material along the north and south shorelines did not enter the river mouth; however, tracer material seaward of the entrance (representing sediment washed out of the river by various discharges) moved into the entrance inside the south jetty for most wave conditions. For test waves from SW, tracer movement was from south to north with material from the south shoreline moving around the head of the south jetty and being deposited between the jetty and entrance channel. For some of the test waves, tracer material seaward of the river mouth migrated into the entrance between the jetties and deposited between the south jetty and the entrance channel and/or in the entrance channel. Test waves from SSW moved the tracer material from south to north. Again, material from the south shoreline moved around the south jetty where some deposited along the inside of the jetty and some deposited in the entrance channel.

Tracer material seaward of the river mouth moved into the entrance for the smaller waves (13-sec, 7-ft test waves), while the larger test waves moved this material to the shoreline north of the river entrance.

46. Results of water-surface elevation and depth-averaged river current velocity measurements for Base Test 2 are shown in Tables 16 and 17 for the 0.0 and +6.7 ft swl's. Water-surface profiles plotted from the data in Table 16 are shown in Plates 22 and 23. Velocities between the jetties at the entrance ranged from 2.7 fps for the 50,000-cfs discharge to 16.7 fps for the 350,000-cfs discharge with the 0.0-ft swl. For the +6.7 ft swl, velocities between the jetties at the entrance ranged from 2.0 to 14.3 fps for the 50,000- and 350,000-cfs discharges, respectively.

47. Long-term shoaling tests were conducted for Base Test 2 for 13-sec, 7-ft test waves from west and 13-sec, 27-ft test waves from SW using the +4.3 ft swl (maximum flood tidal flow). Tracer material moved upstream along the inside of the south jetty and formed a shoal that extended almost to the small-boat basin entrance for test waves from west as shown in Photo 181. For test waves from SW, tracer material penetrated farther upstream and formed a shoal that deposited in the small-boat basin entrance as depicted in Photos 182-184. The shoal formed by test waves from west was subjected to successively larger river discharges with the following results:

a. A 50,000-cfs river discharge had no effect on the shoal.

b. A 100,000-cfs river discharge started sweeping the channel clean around the shoal.

c. A 150,000-cfs river discharge swept the channel clean to the end of the jetties and started eroding the shoal.

d. A 200,000-cfs river discharge eroded the shoal more quickly, and the water level began building up upstream of the shoal.

e. A 250,000-cfs river discharge continued eroding the shoal with rapid erosion occurring at the upstream end due to the water level buildup.

f. A 300,000-cfs river discharge increased the erosion rate of the shoal with slight flooding of the overbank upstream.

g. A 350,000-cfs river discharge caused more severe flooding. After substantial erosion of the shoal had occurred, however, flooding receded.

Shoaling patterns due to erosion resulting from various river discharges are shown in Photos 185-188. These tests were run until patterns and trends developed, but not until equilibrium was reached.

48. A thin veneer of tracer material was placed on the river bottom throughout the lower reaches of the river for Base Test 2 and subjected to various discharges to qualitatively determine the movement of bed-load sediment. These tests were conducted for river discharges ranging from 50,000 to 350,000 cfs and visual observations revealed that a 50,000-cfs river discharge resulted in no movement of riverbed materials. A 100,000-cfs discharge resulted in very slow movement of the material which was slightly more pronounced in the northern portion of the river. Each successively larger discharge (up to 350,000 cfs) resulted in slightly faster movement of the riverbed material. The bed-load sediment tracer moved straight out to sea along the axis of the river and no shoaling between the jetties was noted. Typical movement of tracer material on the riverbed in the lower reaches of the river is presented in Plate 24. Photo 189 shows bed-load movement at and downstream of the small-boat basin entrance.

Improvement plans

49. Long-term shoaling tests were conducted for Plans 1-1B for 13-sec, 27-ft test waves from southwest. For Plan 1, tracer material migrated upstream where it penetrated through the timber-pile dike and into the small-boat basin entrance as shown in Photo 190. The installation of stone along the toe of the dike (Plan 1A) did not improve shoaling conditions. Tracer material moved upstream along the south jetty and over the toe stone toward the small-boat basin entrance. The 200 ft of stone placed at an elevation of +8 ft along the dike next to the south jetty (Plan 1B) initially halted the movement of material along the jetty. However, a shoal soon formed against the dike and each wave crest then carried the material over the structure forming a shoal upstream of the dike along the south jetty. This material eventually

migrated upstream and into the basin entrance.

50. Long-term shoaling tests conducted for Plan 2 for 13-sec, 27-ft test waves from SW resulted in the shoal shown in Photo 191. Tracer material moved over and/or through the seaward dike and migrated upstream toward the inner dike. This inner dike intercepted the movement of tracer material and prevented it from shoaling the small-boat entrance. This shoal was subjected to successively larger river discharges with the following results:

- a. A 50,000-cfs river discharge had no effect on the shoal.
- b. A 100,000-cfs river discharge started sweeping the channel clean around the end of the inner dike.
- c. A 150,000-cfs river discharge began moving material out of the main channel.
- d. A 200,000-cfs river discharge swept the channel clean to the end of the existing jetties.
- e. A 250,000-cfs river discharge swept clean the material around the head of the inner dike. The current started flowing through the outer end of the inner dike eroding the material against it, and the water level began building up upstream of the inner dike.
- f. A 300,000-cfs river discharge began overtopping the inner dike and more rapidly eroded the shoal. Some flooding was noted upstream.
- g. A 350,000-cfs river discharge caused more severe flooding upstream and the erosion rate of the shoal increased.

Shoaling patterns due to erosion resulting from various river discharges are shown in Photos 192-196. These tests were run until patterns and trends developed, but not until equilibrium was reached. A typical wave pattern for Plan 2 is presented in Photo 197.

51. Long-term shoaling tests conducted for Plan 2A resulted in the shoal as shown in Photo 198 for 13-sec, 27-ft test waves from SW. Tracer material moved over and/or through the seaward dike and migrated upstream to the middle dike. It eventually moved over and/or through the middle dike and upstream to the inner dike. This inner dike stopped the upstream movement of tracer material and prevented it from shoaling the small-boat basin entrance. To determine if the small-boat basin would shoal after an extended period of time, prolonged testing was

conducted for Plan 2A. A spit formed at the head of the inner dike and moved northerly toward the main channel as shown in Photo 199. Tracer material did not move toward the small-boat basin entrance. This shoal was subjected to successively larger river discharges with the following results:

a. A 50,000-cfs river discharge had no effect on the shoal.

b. A 100,000-cfs river discharge started eroding the spit at its northernmost portion.

c. A 150,000-cfs river discharge eroded the spit more quickly and material began moving out the main channel.

d. A 200,000-cfs river discharge totally eroded the spit at the head of the inner dike and swept the main channel clean past the end of the existing jetties.

e. A 250,000-cfs river discharge began flowing through the outer end of the inner dike eroding the tracer material piled up against it. Material around the head of the seaward dike began eroding and the water level began building up upstream.

f. A 300,000-cfs river discharge began overtopping the inner dike and more rapidly eroded the shoal. Some overbank flooding was noted upstream.

g. A 350,000-cfs river discharge increased the erosion rate of the shoal and caused more severe flooding upstream.

Shoaling patterns due to erosion resulting from the various discharges are presented in Photos 200-204. Again, these tests were run until patterns and trends developed, but not until equilibrium was reached. A typical wave pattern of Plan 2A is shown in Photo 205.

52. Water-surface elevations obtained in the lower reaches of the river for Plans 2 and 2A, with discharges ranging from 50,000 to 350,000 cfs using the 0.0 and +6.7 ft swl's, are presented in Tables 18 and 19. Water-surface profiles plotted from these data are shown in Plates 25-28. In general, water-surface elevations were higher for Plan 2 than Plan 2A; and for the maximum (350,000 cfs) river discharge they were from 1.8 to 3.4 ft higher upstream of the inner dike for Plan 2.

53. To qualitatively determine bed-load sediment movement throughout the lower reaches of the river for Plan 2A, a thin layer of tracer

material was placed on the river bottom and subjected to various discharges. Visual observations for river discharges ranging from 50,000 to 350,000 cfs revealed that a 50,000-cfs river discharge resulted in no movement of riverbed materials. A 100,000-cfs river discharge resulted in very slow movement of sediment down the river. Immediately upstream of the inner dike, the rate of movement of the bottom material increased, and material on the southern portion of the river flowed toward the north around the dike. Each successively larger discharge resulted in slightly faster movement of the riverbed material. No sediment deposited upstream of the inner dike for any of the flows; however, an eddy formed downstream of the inner dike resulting in slight deposits at the head of the middle dike for 150,000- and 200,000-cfs discharges. For 250,000-cfs discharges and greater, deposits (resulting from eddying) were noted between the seaward and middle dikes. Typical movement of tracer materials on the riverbed in the lower reaches of the river for various discharges are depicted in Plates 29-31. Views of bed-load sediment movement at and downstream of the small-boat basin entrance are shown in Photos 206-208.

54. Results of water-surface elevation measurements obtained for Plans 3-3B are shown in Tables 20-22 for discharges ranging from 50,000 to 350,000 cfs with the 0.0 and +6.7 ft swl's. Water-surface profiles were plotted from these data and are presented in Plates 32-37. A comparison of water-surface elevations for Plans 3-3B in the lower reaches of the river reveals that Plan 3A resulted in lower elevations than the other plans. A view of the conveyance channel and weir section of Plan 3A with a 350,000-cfs river discharge is shown in Photo 209.

55. Tracer material was introduced north of the river entrance to represent sediment from the north shoreline and tests were conducted for Plans 4-4G for representative test waves from NNW. The general movement of tracer material and subsequent deposits for Plan 4 are shown in Photos 210-217. For both the 0.0 and +6.7 ft swl's, test waves moved material around the head of the north jetty. Wave patterns and wave-induced current patterns and magnitudes secured for Plan 4 are presented in Photos 218 and 219. Maximum velocities of 7.7 fps were obtained along the new jetty extension.

56. Tracer movement and resulting deposits for Plan 4A are shown in Photos 220-225. Tracer material deposited north of the jetty and did not move around the head for any of the test waves for either the 0.0 or +6.7 ft swl. Wave patterns and wave-induced current patterns and magnitudes obtained for Plan 4A are presented in Photos 226 and 227. Maximum velocities of 5.0 fps were recorded along the new jetty extension.

57. Results of tracer tests for Plan 4B are shown in Photos 228 and 229. Both these test conditions resulted in tracer material moving around the head of the jetty toward the entrance.

58. The general movement of tracer and subsequent deposits for Plans 4C-4E are presented in Photos 230-241 for representative test waves. The spur deflected tracer movement to the north; and in most cases, material moved around the spur (eddied in a counterclockwise movement) and deposited in the V-shaped area between the spur and the jetty. Considering shoaling protection and construction costs for Plans 4C-4E, Plan 4E appeared to be the most desirable.

59. Results of tracer tests conducted for Plans 4F and 4G are shown in Photos 242-244. Test waves for both these plans resulted in tracer moving around the head of the jetty.

60. Tracer material was introduced south of the river entrance to represent sediment from the south shoreline and tests were conducted for Plan 5 for representative test waves from SSW. The general movement of tracer material and subsequent deposits for Plan 5 are shown in Photos 245-249. For the +6.7 ft swl, two of the three test waves moved material around the head of the south jetty where it deposited along the inside of the jetty. For the 0.0-ft swl, tracer was deposited south of the jetty with no material moving around the head.

61. Results of tracer tests with the south spur installed (Plan 5A-5E) are shown in Photos 250-257. Generally, tracer moved northerly along the shoreline and into a counterclockwise eddy between the spur and the shoreline. For some of the test plans, the tracer then moved around the spur where some moved into the V-shaped area between the spur and the jetty and some moved around the jetty head and deposited along the inside of the south jetty. Considering shoaling

protection and construction costs for Plans 5A-5E, Plan 5E appeared to be the most desirable.

62. Tracer material was introduced into the model north and south of the river mouth to represent sediment from those shorelines and seaward of the jettied entrance to represent sediment from the river. Tracer tests then were conducted for Plan 5E for representative test waves from NNW, west, and SSW using the 0.0, +1.5 (maximum ebb), +4.3 (maximum flood), and the +6.7 ft swl's. Results of these tests are shown in Photos 258-276. Tracer material from the north and south shorelines caused no problem with respect to shoaling in the river entrance; however, various test waves from each direction resulted in material (representing sediment from the river) entering the entrance between the jetties. For test waves from west and SSW, this material penetrated relatively deep into the river entrance with the maximum flood tidal flow (+4.3 ft swl).

63. Wave pattern photographs and current patterns and magnitudes were secured for Plan 5E for maximum ebb (+1.5 ft swl) and maximum flood (+4.3 ft swl) tidal conditions and the +6.7 ft swl (no flow) for 11-sec, 12-ft test waves from NNW and SSW and are presented in Photos 277-282. Maximum velocities at various locations were as follows:

Location	Maximum Velocity, fps	Wave Direction	swl
Shoreline south of south jetty	5.0	SSW	+1.5
Area along south jetty extension	4.0	SSW	+1.5
Area seaward of entrance	7.8	NNW	+4.3
Area between jetties, south of channel	7.1	NNW	+4.3
Channel	4.0	SSW	+4.3
Area along north jetty extension	10.0	NNW	+4.3
Shoreline north of north jetty	7.1	NNW	+6.7

64. Long-term shoaling tests conducted for Plan 5E for 13-sec, 27-ft test waves from SW resulted in the shoal shown in Photos 283 and 284. Wave energy moved the tracer upstream along the south jetty resulting in a shoal that extended into the small-boat basin entrance.

65. Tracer material was introduced into the model south of the river mouth to represent sediment from the south shoreline for Plans 6-6D for representative test waves from SSW using the 0.0 and/or +6.7 ft swl. For Plans 6 and 6A, tracer material moved along the south jetty extension, around the head of the extension, and into the entrance as shown in Photos 285 and 286. Plans 6B-6D resulted in no tracer material moving around the head of the south jetty extension. Generally, tracer material moved northerly along the shoreline and into a counterclockwise eddy between the spur and the shoreline. In some instances, with the +6.7 ft swl, the tracer material then moved around the spur and into a clockwise movement seaward of the spur. The general movement of tracer material and subsequent deposits for Plans 6B-6D are presented in Photos 287-294. Considering shoaling protection and costs for Plans 6-6D, Plan 6D appeared to be the most desirable.

66. Tracer material was introduced north of the river entrance for Plans 7-7J to represent sediment from the north shoreline and tests were conducted for representative test waves from north-northwest using the 0.0 and/or +6.7 ft swl. The general movement of tracer material and subsequent deposits for Plans 7-7J are shown in Photos 295-306. Test waves for most of the improvement plans (Plans 7-7D and 7F-7I) resulted in tracer material moving around the north jetty extension head and into the entrance between the new jetty extensions. Plans 7E and 7J prevented the movement of tracer into the entrance, and Plan 7J was selected for further testing.

67. Tracer was introduced in the model north and south of the river mouth to represent sediment from those shorelines and seaward of the jettied entrance to represent sediment from the river. Tracer tests then were conducted for Plan 7J for representative test waves from NNW, SW, and SSW using the 0.0, +1.5 (maximum ebb), +4.3 (maximum flood), and +6.7 ft swl's. Results of these tests are shown in Photos 307-324.

Tracer material from the north and south shorelines caused no problem with respect to shoaling in the river entrance; however, various test waves from each direction resulted in material (representing sediment from the river) entering the entrance between the jetties. Wave patterns secured for Plan 7J for representative test waves from NNW, west, SW, and SSW are presented in Photos 325-330.

68. Long-term shoaling tests conducted for Plan 7J for 11-sec, 12-ft test waves from west using the +4.3 ft swl and the maximum flood tidal flow resulted in the shoal as shown in Photos 331 and 332. Wave energy moved most the tracer upstream along the south jetty, but the shoal did not extend to the small-boat basin entrance. A relatively minor shoal formed against the north jetty. This shoal then was subjected to 13-sec, 21-ft test waves from west with the maximum flood tidal flow, but little change occurred. Tracer material did not penetrate farther upstream for these 21-ft waves.

69. Water-surface elevations obtained in the lower reaches of the river for Plan 7J for discharges ranging from 50,000 to 350,000 cfs using the 0.0 and +6.7ft swl's are presented in Table 23. Water-surface profiles, plotted from these data are shown in Plates 38 and 39. These data, when compared with those of existing (no-shoal) conditions (Base Test 2), reveal that the Plan 7J jetty extension had negligible effects on water-surface elevations in the lower reaches of the river for the various discharges.

70. Tracer material was introduced south of the river entrance for Plans 8-8D to represent sediment on the south shoreline and tests were conducted for representative test waves from SSW using the 0.0 and/or +6.7 ft swl. For Plans 8-8B, tracer material moved along the south jetty extension where some of the material moved across the channel and some moved around the jetty head into the entrance as shown in Photos 333-336. Plans 8C and 8D resulted in no tracer deposits in the entrance. Generally, tracer material moved northerly along the shoreline and into a counterclockwise eddy south of the south jetty. The general movement of tracer material and subsequent deposits for Plans 8C and 8D are presented in Photos 337-343. Considering shoaling protection and

costs for Plans 8-8D, Plan 8D appeared to be the most desirable.

71. Tracer material was introduced into the model north of the river entrance for Plans 8D and 9 to represent sediment from the north shoreline and tests were conducted for representative waves from NNW using the 0.0-ft swl. The general movement of tracer material and subsequent deposits for Plans 8D and 9 are shown in Photos 344-346. For both plans, tracer material moved along the north jetty extension, around the head, and toward the south shoreline. Plan 8D, being more suitable to navigation than Plan 9, was selected for further testing.

72. Tracer was introduced into the model north and south of the river mouth to represent sediment from those shorelines and seaward of the jettied entrance to represent sediment from the river. Tracer tests then were conducted for Plan 8D for representative test waves from NNW, west, SW, and SSW using the 0.0, +1.5 (maximum ebb), +4.3 (maximum flood), and +6.7 ft swl's. Results of these tests are depicted in Photos 347-372. Tracer movement for test waves from NNW presented no shoaling problem. Tracer material moved from the north shoreline around the structures to the south shoreline. These structures created a natural bypassing condition. For test waves from west, SW, and SSW, tracer material from the north and south shorelines caused no problem with respect to shoaling. Most of the material (representing sediment from the river) moved to the shoreline south of the south jetty for test waves from west with only small deposits occurring along the south jetty head. Test waves from southwest moved most of this material into the entrance between the jetties (particularly for the lower swl) with some moving to the shoreline south of the south jetty; and most of the test waves from SSW resulted in tracer entering the entrance between the jetties. Wave pattern photographs secured for Plan 8D for representative test waves from the four test directions are presented in Photos 373-376.

73. Long-term shoaling tests conducted with Plan 8D installed for 11-sec, 13-ft waves from SW using the 0.0-ft swl resulted in the shoal depicted in Photos 377-378. Wave energy moved the tracer material upstream along the south jetty extension where it extended northerly across

the entrance. Due to the Plan 8D jetty configuration, wave energy reaching the lower reaches of the river was substantially reduced, therefore preventing the movement of tracer material upstream toward the small-boat basin entrance.

74. Results of water-surface elevation measurements secured for Plan 8D are shown in Table 24 for discharges ranging from 50,000 to 350,000 cfs with the 0.0 and +6.7ft swl's. Water-surface profiles were plotted from these data and are presented in Plates 40 and 41. These data, when compared with those of existing conditions (Base Test 2), reveal that the Plan 8D jetty extensions had negligible effects on water-surface elevations in the lower reaches of the river for the various discharges.

75. Tracer material was introduced in the model south of the new entrance for Plans 10-10J to represent sediment from the south shoreline and tests were conducted for representative test waves from SSW using the 0.0 and/or +6.7 ft swl. Tracer material moved along the new south jetty, around the head, and into the entrance for Plans 10-10F, while the 600-ft jetty extension of Plan 10G prevented the movement of tracer into the entrance. The general movement of tracer material and subsequent deposits for Plans 10-10G are presented in Photos 379-387. For the improvement plans involving the installation of the spur south of the new south jetty, tracer material generally moved northerly along the shoreline and into a counterclockwise eddy between the spur and the shoreline. For the +6.7 ft swl, the tracer then moved around the spur and into a clockwise movement seaward of the spur. Material moved around the head of the new south jetty and into the entrance for Plans 10H and 10I, while the 300-ft-long spur of Plan 10J prevented the movement of tracer material into the entrance. Results of tracer tests for Plans 10H-10J are shown in Photos 388-393. Considering shoaling protection and costs for Plans 10-10J, Plan 10J appeared to be the most desirable.

76. Tracer material was introduced into the model north and south of the jetties to represent sediment from those shorelines and seaward of the river mouth to represent sediment from the river. Tracer tests

then were conducted for Plans 10J and 11-11B for representative test waves from NNW using the 0.0 and/or +6.7 ft swl. Results of these tests are shown in Photos 394-402. For Plans 10J and 11, material from the north shoreline and material representing sediment from the river moved around the head of the middle jetty and into the new entrance. For Plans 11A and 11B, tracer moved along the middle jetty, around the head, and toward the south shoreline. Plan 11A, however, resulted in deposits at the head of the middle structure that possibly could penetrate the jetties for test waves from other directions (i.e., test waves from west, which is considered the predominant wave direction in the area). Plan 11B created a natural bypassing condition for test waves from NNW (particularly for the lower swl) and appeared to be the optimum plan with regard to shoaling protection. Tracer tests then were conducted for Plan 11B for representative test waves from west, SW, and SSW using the 0.0 and +6.7 ft swl's. Results of these tests are presented in Photos 403-420. Tracer material did not move into the entrance for any of these test waves. Wave patterns obtained for Plan 11B for representative test waves from NNW, west, SW, and SSW are shown in Photos 421-424.

77. Wave-height tests were conducted for Plan 11B for representative test waves from SW and SSW using the +6.7 ft swl. Results of these tests are presented in Table 25. Maximum wave heights obtained were 19.6 ft in the entrance at the seaward end of the jetties (gage 22) for 9-sec, 17-ft test waves from SSW; 1.8 ft at the upper end of the channel (gage 18) for 17-sec, 12-ft test waves from SW; and 0.9 ft inside the small-boat harbor (gage 13) for 13-sec, 21-ft test waves from SSW and 13-sec, 13-ft test waves from SW.

<u>Discussion of test results</u>

78. Test results obtained for existing conditions during periods when the shoal is present (Base Test 1) revealed rough and turbulent wave activity in the Rogue River entrance due to waves breaking on the shoal in the southern portion of the river. During periods when the shoal is not present (Base Test 2), however, test results indicated a significant increase in wave heights upstream of the small-boat harbor entrance. For example, maximum wave heights of 3.7 ft were obtained upstream of

the U. S. 101 Highway Bridge for Base Test 2 versus maximum wave heights of 1.3 ft at the same location for Base Test 1. Additionally, maximum wave heights of 5.5 and 1.7 ft were obtained along the revetment on the north bank just downstream of the bridge for Base Test 2 and Base Test 1, respectively.

79. A comparison of water-surface elevations and river current velocities obtained for existing conditions both with and without the shoal in the entrance reveals that as expected, higher stages and greater current velocities occur for conditions when the shoal is present (Base Test 1). Test results for Base Test 1 represent values that could be expected before erosion of the shoal occurs. Since the fixed-bed shoal in the model allowed no erosion, at some point the data obtained becomes unrealistic. Particularly at the higher discharges, the shoal should erode quickly in the prototype, substantially reducing river stages and current velocities. These tests definitely indicated that the shoal interfered with the passage of flood flows; however, the extent of this interference for the higher discharges could not be determined in the fixed-bed model.

80. An evaluation of tracer tests conducted for existing conditions (Base Test 1 and Base Test 2) indicates that shoaling will occur in the lower reaches of the river for various test waves and swl's for each wave direction. This shoal was nourished by sediment from the following sources (depending on wave direction): (a) the north shoreline, (b) the south shoreline, and/or (c) sediment seaward of the entrance (representing sediment from the river). Generally, material deposited in the southern portion of the river adjacent to the south jetty. Under constant wave attack from test waves from west and/or southwest, this material would congregate against the south jetty and migrate upstream across the entrance to the small-boat basin as determined by the long-term shoaling tests conducted for Base Test 2.

81. Test results obtained with the timber-pile dike installed in the model (Plans 1-1B) revealed that shoaling would occur in the small-boat basin entrance channel. Even with toe stone installed and stone placed at a +8 ft elevation against the dike, material eventually

penetrated the structure and migrated upstream and into the small-boat basin entrance.

82. Test results obtained for the two rubble-mound dikes of Plan 2 and the three rubble-mound dikes of Plan 2A indicated that both plans prevented shoaling of the small-boat basin entrance. Water-surface elevations were greater for Plan 2 than Plan 2A with river stages ranging from 1.8 to 3.4 ft higher upstream of the inner dike for the maximum (350,000 cfs) discharge. Water-surface elevations for Plan 2A, however, when compared with those of existing (no-shoal) conditions (Base Test 2), resulted in river stages ranging from 2.6 to 4.6 ft higher upstream of the inner dike for the maximum discharge. The riverine sediment discharge tests performed for Plan 2A indicated that there were no tendencies for trapping sediment upstream of the inner dike for any of the riverflows tested; however, slight deposits occurred downstream due to eddying effects.

83. A comparison of water-surface elevations for various plans (Plans 3-3B) with the weir section in the north jetty and the conveyance channel used in conjunction with the Plan 2 series dike plans revealed that Plan 3A resulted in lower river stages in the lower reaches of the river than Plans 3 and 3B. However, when compared with existing (no-shoal) conditions (Base Test 2), water-surface elevations for Plan 3A ranged from 2.0 to 3.9 ft higher upstream of the weir section for the maximum (350,000 cfs) discharge. The conveyance channel and weir section of Plan 3A actually only reduced river stages upstream by less than 1 ft.

84. A comparison of test results for various plans involving extensions of the existing jetties on their original alignment (Plans 4-4G and 5-5E) revealed that Plan 5E would prevent the movement of sediment from the north and south shorelines into the entrance; however, sediment deposited by various river discharges seaward of the entrance would penetrate relatively deep into the river entrance for some test conditions. Long-term shoaling tests for Plan 5E indicated that a shoal would form adjacent to the south jetty and migrate upstream across the small-boat entrance.

85. An evaluation of test results for the plans involving jetty extensions oriented toward the west on an azimuth of S 81°41'30" W (Plans 6-6D and 7-7J) revealed that Plans 7E and 7J would prevent the movement of sediment from the north and south shorelines into the entrance. Various test waves from each direction, however, resulted in material seaward of the entrance (representing sediment from the river) entering between the jetties. Long-term shoaling tests for Plan 7J indicated that a shoal would form in the entrance along the south jetty but would not extend to the small-boat basin entrance. A small shoal would also form against the north jetty. Water-surface elevations obtained for Plan 7J, when compared with those of existing (no-shoal) conditions (Base Test 2), revealed that the jetty extensions had negligible effects on river stages for the various discharges.

86. An evaluation of test results for the plans involving jetty extensions oriented toward the south on an azimuth of S 16°23'22" W (Plans 8-8D and 9) indicated that Plans 8D and 9 would provide shoaling protection to the entrance for sediment from the north and south shorelines. Sediment from the north shoreline moved around the north jetty extension and toward the south shoreline for some test waves, creating a natural bypassing condition. Material deposited seaward of the entrance (representing sediment from the river), however, moved into the entrance for several test waves. Long-term shoaling tests conducted for Plan 8D indicated that a shoal would form along the south jetty extension and extend northerly into the channel. Since the amount of wave energy reaching the lower reaches of the river was substantially reduced (due to the angled jetty configuration), the movement of sediment upstream toward the small-boat harbor entrance is reduced. Water-surface elevations secured for Plan 8D revealed that the jetty extensions had negligible effects on river stages for various discharges (when compared with those of existing conditions, Base Test 2).

87. Evaluation of test results for the plans involving a new entrance south of the existing river mouth (Plans 10-10J and 11-11B) reveals that Plan 11B would prevent the movement of sediment from all three sources into the new entrance. The structure orientation created

a natural bypassing condition for some test waves where the sediment on the north shoreline moved around the new middle jetty and toward the south shoreline. Wave heights in the harbor were less than 1 ft for Plan 11B.

PART V: CONCLUSIONS

88. Based on the results of the hydraulic model investigation reported herein, it is concluded that:

a. During periods when the shoal is present (Base Test 1), rough and turbulent wave conditions exist in the entrance due to waves breaking on the shoal.

b. During periods when the shoal is present (Base Test 1), higher than normal river stages and river current velocities may result for various discharges since the shoal interferes with the passage of flood flows.

c. During periods when the shoal is not present (Base Test 2), increased wave heights can be expected upstream of the small-boat harbor entrance.

d. Wave-induced shoaling will occur in the river entrance for existing conditions for various waves from each direction, and the shoal will migrate upstream across the small-boat harbor entrance for waves from west and/or southwest.

e. The installation of a timber-pile dike extending from the south jetty (Plans 1-1B) will not prevent shoaling of the small-boat harbor entrance channel.

f. The installation of the two rubble-mound dikes of Plan 2 and the three rubble-mound dikes of Plan 2A will prevent shoaling of the small-boat harbor entrance; however, each plan (Plan 2A to a lesser extent) will result in increased water-surface elevations upstream of the inner dike as compared with a no-shoal existing condition (Base Test 2).

g. The Plan 2A rubble-mound dikes extending from the south jetty have no tendencies for trapping river bed-load sediment upstream of the inner dike for the various discharges tested.

h. The conveyance channel and weir section of Plan 3A reduced river stages upstream by less than 1 ft and therefore were not successful in decreasing water-surface profiles to desired levels.

i. Of the improvement plans tested involving extensions of the existing jetties on their original alignment (Plans 4-4G and 5-5E), Plan 5E will provide shoaling protection from sediment on the north and south shorelines; however, sediment from the river will form a shoal in the entrance adjacent the south jetty that will extend upstream across the small-boat harbor entrance.

j. Of the improvement plans tested involving jetty extensions oriented toward the west on an azimuth of S 81°41'30" W (Plans 6-6D and 7-7J), Plans 7E and 7J will prevent shoaling of the entrance from sediment on the north and south shorelines; however, sediment from the river will form shoals in the entrance but will not extend upstream to the small-boat harbor entrance.

k. Of the improvement plans tested involving jetty extensions oriented toward the south on an azimuth of S 16°23'22" W (Plans 8-8D and Plan 9), Plans 8D and 9 will prevent shoaling of the entrance from sediment on the north and south shorelines; however, sediment from the river will result in a shoal along the south jetty extension extending northerly in the entrance. This shoal will not extend upstream to the small-boat basin entrance.

l. The jetty extensions of Plans 7J and 8D would have negligible effects on water-surface elevations in the lower reaches of the river for the various discharges.

m. Of the improvement plans tested involving a new entrance south of the existing river mouth (Plans 10-10J and 11-11B), Plan 11B will provide shoaling protection for the new entrance from sediment on the north and south shorelines and sediment deposited seaward of the river entrance by various discharges.

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Table 1

Summary of Refraction and Shoaling Analysis for Rogue River, Oregon

Deepwater Direction deg	Wave Period sec	Shallow-Water* Azimuth deg	Refraction* Coefficient	Shoaling** Coefficient	Wave-Height Adjustment Factor
North (360)	5	346.3	0.85	1.00	0.85
	7	332.7	0.49	0.99	0.49
	9	329.2	0.54	0.95	0.51
	11	311.0	0.53	0.92	0.49
NNW (337.5)	5	334.3	0.98	1.00	0.98
	7	327.7	0.93	0.99	0.92
	9	311.5	0.90	0.95	0.86
	11	312.0	0.84	0.92	0.77
	13	306.3	0.73	0.91	0.66
NW (315)	5	313.3	1.01	1.00	1.01
	7	306.7	0.89	0.99	0.88
	9	303.3	0.88	0.95	0.84
	11	289.2	0.82	0.92	0.75
	13	283.2	0.92	0.91	0.84
	15	279.2	0.97	0.93	0.90
	17	277.8	0.86	0.95	0.82
WNW (292.5)	5	292.3	1.01	1.00	1.01
	7	288.0	0.96	0.99	0.95
	9	281.4	0.99	0.95	0.94
	11	277.8	1.00	0.92	0.92
	13	271.8	0.89	0.91	0.81
	15	269.6	0.88	0.93	0.82
	17	269.9	0.85	0.95	0.81
	19	268.0	0.87	0.98	0.85
WES (270)	5	270.0	1.00	1.00	1.00
	7	268.1	1.00	0.99	0.99
	9	264.7	0.98	0.95	0.93
	11	262.5	1.01	0.92	0.93
	13	261.2	1.05	0.91	0.96
	15	259.9	0.89	0.93	0.83
	17	259.2	0.87	0.95	0.83
	19	258.6	0.84	0.98	0.82

(Continued)

* At model contours.

** At 120-ft depth (model pit elevation).

Table 1 (Continued)

Deepwater Direction deg	Wave Period sec	Shallow-Water Azimuth deg	Refraction Coefficient	Shoaling Coefficient	Wave-Height Adjustment Factor
WSW (247.5)	5	247.6	1.00	1.00	1.00
	7	247.8	1.00	0.99	0.99
	9	248.1	1.01	0.95	0.96
	11	247.7	1.06	0.92	0.98
	13	250.0	1.10	0.91	1.00
	15	249.4	1.12	0.93	1.04
	17	248.9	1.13	0.95	1.07
SW (225)	5	225.3	1.00	1.00	1.00
	7	227.7	0.99	0.99	0.98
	9	230.6	0.94	0.95	0.89
	11	235.5	0.92	0.92	0.85
	13	237.5	0.90	0.91	0.82
	15	239.9	0.88	0.93	0.82
SSW (202.5)	5	204.5	0.97	1.00	0.97
	7	207.5	0.93	0.99	0.92
	9	218.5	0.84	0.95	0.80
	11	224.2	0.86	0.92	0.79
	13	224.7	0.80	0.91	0.73
	15	226.6	0.81	0.93	0.75
South (180)	5	189.4	0.70	1.00	0.70
	7	205.0	0.55	0.99	0.54
	9	216.7	0.57	0.95	0.54
	11	219.6	0.63	0.92	0.58
	13	224.1	0.55	0.91	0.50
	15	222.0	0.35	0.93	0.33

Table 2

Estimated Duration and Magnitude of Deepwater Waves (Sea and Swell, Sta 1) Approaching Rogue River from the Directions Indicated (National Marine Consultants 1960)

Wave Height ft	Duration hr/yr per Wave Period, sec 4-6	6-8	8-10	10-12	12-14	14-16	16-18	Total
				North				
1-3	454	55						509
3-5	61	484	30					576
5-7	2	141	56	7				206
7-9		20	183	2				205
9-11			61	16				77
11-13			2	13				15
13-15			2					2
15-17				2				2
Total	517	701	334	40				1592
				North-Northwest				
1-3	273	14	51	71	3			412
3-5	61	398	52	11	7			529
5-7		178	32	8	3			221
7-9		9	200	3	3			215
9-11			58	15				73
11-13				16				16
13-15				2				2
15-17				5				5
Total	334	599	393	131	16			1473
				Northwest				
1-3	303	179	495	600	50	18		1645
3-5	50	507	214	103	42	23	4	943
5-7		118	113	55	16	9	4	315
7-9		2	131	51	18	6	4	212
9-11			31	27	4	8		70
11-13			2	31	14	2	2	51
13-15			3	6	4	2		15
15-17			3		4	2		9
17-19			3	4	4			11

(Continued)

Table 2 (Continued)

Wave Height ft	Duration hr/yr per Wave Period, sec 4-6	6-8	8-10	10-12	12-14	14-16	16-18	Total
				Northwest (Continued)				
19-21								
21-23					4			4
Total	353	806	995	877	160	70	14	3275
				West-Northwest				
1-3	26	191	409	317	76	68	16	1103
3-5	10	229	430	231	111	52	18	1081
5-7		59	177	171	99	30	11	547
7-9		6	66	80	53	7	9	221
9-11		5	20	50	19	13	6	113
11-13			4	23	18	14	4	63
13-15				13	6	6		25
15-17				4	7	2	2	15
17-19					4	2	2	8
19-21					11	2		13
21-23					2			2
Total	36	490	1106	889	406	196	68	3191
				West				
1-3	121	213	335	312	68	44	37	1130
3-5	24	345	349	184	111	60	24	1097
5-7		77	189	102	54	46	14	482
7-9		4	104	98	52	22	9	289
9-11		2	38	47	23	6	2	118
11-13			9	27	18	6		60
13-15			5	18	15	6		44
15-17				24	11	8		43
17-19				4	17	4		25
19-21					4	6	2	12
21-23					2	2		4
Total	145	641	1029	816	375	210	88	3304
				West-Southwest				
1-3	26	72	124	81	32	18	6	359
3-5	9	132	113	58	13	11	2	338

(Continued)

Table 2 (Continued)

Wave Height ft	Duration hr/yr per Wave Period, sec							
	4-6	6-8	8-10	10-12	12-14	14-16	16-18	Total
				West-Southwest (Continued)				
5-7		33	50	39	20	11	2	155
7-9		2	74	25	2	6		109
9-11			22	6	6	2		36
11-13			5	8	8			21
13-15				4	2			6
15-17								
17-19					2		2	4
19-21								
21-23								
23-25					6	2		8
Total	35	239	388	221	91	50	12	1036
				Southwest				
1-3	214	56	93	110	11	2		486
3-5	32	238	56	16	4	4		350
5-7		65	26	16				107
7-9		4	109	12	2	2	2	131
9-11			20	24				44
11-13			7	4	4			15
13-15			7	11	4		2	24
15-17				2		2		4
17-19					9			9
Total	246	363	318	195	34	10	4	1170
				South-Southwest				
1-3	41	18	28	54	2	2		145
3-5	17	87	16	6	8			134
5-7		27	8	11	2			48
7-9		2	64					66
9-11			21	2				23
11-13			5	7				12
13-15			7	12				19
15-17			5	2				7
17-19				7				7
19-21				12	11			23
Total	58	134	154	113	23	2		484

(Continued)

(Sheet 3 of 4)

Table 2 (Concluded)

Wave Height ft	Duration hr/yr per Wave Period, sec							
	4–6	6–8	8–10	10–12	12–14	14–16	16–18	Total
				South				
1–3	313	34	46	26				419
3–5	80	229	60	4	2	2		377
5–7		136	13	2				151
7–9		16	187	10				213
9–11			10	10				20
11–13			22	20	5			47
13–15			17	43				60
15–17			7	20				27
17–19				30	5			35
19–21			2	5	9			16
Total	393	415	364	170	21	2		1365

Table 3

Shipboard Observations of Deepwater Waves (Sea and Swell)
Approaching Rogue River from the Directions Indicated
(National Climatic Center 1976)

Wave Height ft	Observations* per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					North				
0- 3.3	2523	364	64	14	9	6	1	28	3009
3.3- 6.6	4933	2167	758	137	45	30	8		8078
6.6- 9.8	1199	1202	763	228	44	33	1		3470
9.8-13.1	230	405	358	162	94	17	2		1268
13.1-16.4	49	101	90	34	30	10	1		315
16.4-19.7	13	24	21	5	4	7			74
19.7-23.0	1	12	11	2	7	4			37
23.0-26.2		2	5	1	2				10
26.2-29.5		1	1	1	2				5
29.5-32.8	1			1					2
32.8-36.1			1						1
Total	8949	4278	2072	585	237	107	13	28	16,269
					North-Northwest				
0- 3.3	1856	327	99	16	32	5	1	20	2356
3.3- 6.6	3729	2137	724	131	71	19	2	13	6826
6.6- 9.8	938	1219	754	163	57	35	3	1	3170
9.8-13.1	164	343	319	108	56	18	3		1011
13.1-16.4	33	107	90	33	28	7	1	1	300
16.4-19.7	12	19	22	5	12	1			71
19.7-23.0	2	13	15	7	3	4			44
23.0-26.2	1	4	7	1	2	1	1		17
26.2-29.5	1	1	4	1	1	1			9
29.5-32.8		2	1	1					4
32.8-36.1		1							1
Total	6736	4173	2035	466	262	91	11	35	13,809

(Continued)

* Based on total of 131,643 observations from 1950-1975.

Table 3 (Continued)

Wave Height ft	Observations per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					Northwest				
0- 3.3	1962	489	171	24	20	9	2	28	2705
3.3- 6.6	3908	2763	1165	206	90	43	4	19	8198
6.6- 9.8	873	1402	1006	240	89	40	6	1	3657
9.8-13.1	167	401	380	147	87	41	6	1	1230
13.1-16.4	36	135	160	65	40	18	3	2	459
16.4-19.7	11	26	38	14	23	7			119
19.7-23.0	5	17	23	17	9	5	2		78
23.0-26.2		8	6	4	7	3			28
26.2-29.5		1	6	1	4	2			14
29.5-32.8		2	2			1			5
32.8-36.1	1	1	1		2				5
Total	6963	5245	2958	718	371	169	23	51	16,498
					West-Northwest				
0- 3.3	1701	497	200	22	32	10	3	4	2469
3.3- 6.6	3072	2348	1316	231	78	52	2	6	7105
6.6- 9.8	690	1102	1056	361	108	39	7	2	3365
9.8-13.1	119	397	432	205	124	27	3		1307
13.1-16.4	43	109	159	70	68	26	7	1	483
16.4-19.7	4	25	36	24	23	12			124
19.7-23.0	4	8	17	17	12	9	3		70
23.0-26.2		2	9	2	5	7	1	1	27
26.2-29.5	3	2	3		2	1	1		12
29.5-32.8		1	2		1	1			5
32.8-36.1		1	3			2			6
36.1-39.4				1					1
39.4-42.7					1	1			2
Total	5636	4492	3233	933	454	187	27	14	14,976

(Continued)

Table 3 (Continued)

Wave Height ft	Observations per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
				West					
0- 3.3	1455	510	249	26	55	11	1	21	2328
3.3- 6.6	2714	2251	1302	239	131	53	2	6	6698
6.6- 9.8	660	1176	1139	381	122	70	4	3	3555
9.8-13.1	157	435	485	200	135	70	8	3	1493
13.1-16.4	37	224	189	66	77	38	9		640
16.4-19.7	7	38	59	18	26	12	1	1	162
19.7-23.0	2	10	19	20	26	10	1		88
23.0-26.2		6	7	9	9	2	1	1	35
26.2-29.5		2	3	2	4	3	2	2	18
29.5-32.8		2	4	3	1	6			16
32.8-36.1				1	1				2
36.1-39.4									
39.4-42.7		1			1				2
Total	5032	4655	3456	965	588	275	29	37	15,037
				West-Southwest					
0- 3.3	1314	455	193	18	21		2	9	2012
3.3- 6.6	2467	1800	905	148	78	25	6	3	5432
6.6- 9.8	576	939	723	238	79	41	2	1	2599
9.8-13.1	149	369	407	158	105	35	3		1226
13.1-16.4	30	107	148	62	34	23	5	2	411
16.4-19.7	10	36	53	17	7	6	3		132
19.7-23.0	5	12	24	9	15	5			70
23.0-26.2		4	8	2	2	3	2	2	23
26.2-29.5		3	7	1	2	1			14
29.5-32.8	1		4	2	1		1	1	10
32.8-36.1					3	1			4
Total	4552	3725	2472	655	347	140	24	18	11,933

(Continued)

(Sheet 3 of 5)

Table 3 (Continued)

Wave Height ft	Observations per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					Southwest				
0- 3.3	903	213	62	5	8	1	1	11	1204
2.3- 6.6	1850	1082	379	74	47	11	2	4	3449
6.6- 9.8	463	652	441	129	42	23	2	3	1755
9.8-13.1	93	219	232	78	54	20	1	1	698
13.1-16.4	35	88	93	45	21	22			304
16.4-19.7	3	22	32	9	9	3			78
19.7-23.0	1	15	18	5	9				48
23.0-26.2	2	6	4	1	1	3			17
26.2-29.5		4	2		1	5			12
29.5-32.8		1	1	2	3				7
32.8-36.1	1					1			2
Total	3351	2302	1264	348	195	89	6	19	7574
					South-Southwest				
0- 3.3	843	155	44	2	1	1		7	1053
3.3- 6.6	1749	827	273	47	14	13		6	2929
6.6- 9.8	438	541	331	70	27	9	3	2	1421
9.8-13.1	104	267	176	60	29	16	1	1	654
13.1-16.4	29	71	93	38	20	10	3		264
16.4-19.7	5	23	34	6	12	2			82
19.7-23.0	7	4	16	5	8	7	1	1	49
23.0-26.2	1	4	5	2		2			14
26.2-29.5	2	4	1	1		2	1		11
29.5-32.8			2	2		1			5
32.8-36.1			1						1
36.1-39.4	1					1			2
Total	3179	1896	976	233	111	64	9	17	6485

(Continued)

(Sheet 4 of 5)

Table 3 (Concluded)

Wave Height ft	Observations per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					South				
0- 3.3	1496	163	45	12	1	4	1	11	1733
3.3- 6.6	3007	1058	306	63	24	9	3	7	4477
6.6- 9.8	802	868	441	164	34	12	3	2	2326
9.8-13.1	205	406	273	87	66	21	3	1	1062
13.1-16.4	83	143	145	57	36	14	9	4	491
16.4-19.7	13	38	73	31	17	1	5	1	179
19.7-23.0	8	15	33	19	18	7			100
23.0-26.2	4	7	21	4	14	7			57
26.2-29.5	1	4	4	5	3	1			18
29.5-32.8	2	6	4	2	1	1			16
32.8-36.1	1	1		1	1				4
36.1-39.4			1						1
39.4-42.7					1				1
Total	5622	2709	1346	445	216	77	24	26	10,465

(Sheet 5 of 5)

Table 4

Estimated Frequencies* of Deepwater Waves Approaching Rogue River from the Directions Indicated (Fleet Numerical Weather Center)

Wave Height ft	Occurrences per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					North				
>3	29	3	2	3	1			75	113
3-6	80	51	5	7				1	144
6-9	13	47	30	4	1				95
9-12		3	16	5					24
12-15		1		1					2
Total	122	105	53	20	2			76	378
					North-Northwest				
>3	19	2					1		22
3-6	54	38	6	3			1		102
6-9	7	23	7	4	1				42
9-12	1	4	7	3	1				16
12-15				1					1
15-18									
18-21						1			1
21-24						1			1
Total	81	67	20	11	2	2	2		185
					Northwest				
<3	17	3	1	1	1				23
3-6	45	27	8	3	2	1			86
6-9	5	18	16	5	2	1	1	1	49
9-12	1	3	9	5	1	1	1		21
12-15		1	2	3	2	1	1	1	11
15-18				2	1		1		4
18-21						1		1	2
21-24				1		1		1	3
Total	68	52	36	20	9	6	4	4	199

(Continued)

* Based on 2,798 occurrences from 11 April 1969 - 14 December 1977.

(Sheet 1 of 3)

Table 4 (Continued)

Wave Height ft	Occurrences per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					West-Northwest				
>3	12	1	1				1	1	16
3-6	38	25	12	8	8	8	4		103
6-9	3	23	15	6	9	10	6	9	81
9-12		3	8	4	3	4	2	5	29
12-15			3	2	1	1	2	1	10
15-18		1		2		2	2		7
18-21								1	1
21-24								1	1
24-27					1		1		2
27-30								1	1
Total	53	53	39	22	22	25	18	19	251
					West				
<3	21	12	11	13	10	4	3	1	75
3-6	50	37	46	47	31	15	9	4	239
6-9	10	16	28	62	39	11	20	9	195
9-12	3	4	11	51	30	14	8	10	131
12-15	1	1	6	9	26	9	10	5	67
15-18	1	1	3	5	16	10	6	3	45
18-21	1		1	1	5	4	13	1	26
21-24				1	3	1	3	2	10
24-27					1	2	1	1	5
27-30			1				2	4	7
Total	87	71	107	189	161	70	75	40	800
					West-Southwest				
<3	7	3	1	1					12
3-6	32	19	8	8	6	2	4	1	80
6-9	2	14	12	11	8	5	3	2	57
9-12	3	5	8	12	7	1	4	2	41
12-15	2	1	4	6	7	4	2	2	28
15-18			3	5	11	3	2		24
18-21				2	4	2	1	1	10
21-24				1		1		1	3
24-27				1	1	1	1		4
27-30						2	1		3
Total	46	42	36	47	44	21	18	9	263

(Continued)

Table 4 (Concluded)

Wave Height ft	Occurrences per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
Southwest									
<3	12	3	6	6	2	1			30
3-6	27	15	11	7	5	1	2	1	69
6-9	7	15	8	12	5	8	1		56
9-12	1	5	11	13	4	3	3	1	41
12-15		2	3	12	5	3	4	1	30
15-18			1	6	4	1	2		14
18-21				2	3	1	2		8
21-24				1	3	1			5
24-27					1		1		2
27-30						1		1	2
Total	47	40	40	59	32	20	15	4	257
South-Southwest									
<3	14	4	2						20
3-6	18	14	7	3	2		1		45
6-9	7	17	19	2	2	1			48
9-12	1	4	13	12	1	2	1		34
12-15	1	1	7	14	4	1			28
15-18		1	1	8	7	1	1		19
18-21			1	5	1	1			8
21-24					1	2	1		4
24-27						1	1		2
27-30					1	1	2	2	6
Total	41	41	50	44	19	10	7	2	214
South									
<3	16	1	2	1	1			1	22
3-6	21	18	9	3	1	1			53
6-9	8	21	18	6	3	1			57
9-12	1	5	20	16	3			1	46
12-15		2	4	18	5		1	2	32
15-18	1	1	1	13	5	1	1	1	24
18-21		1		2	3	1	1		8
21-24				1	2	1	1		5
24-27					1	1	1		3
27-30						1			1
Total	47	49	54	60	24	7	5	5	251

(Sheet 3 of 3)

Table 5

Estimated Duration and Magnitude of Shallow-Water Waves (Sea and Swell, Sta 1) Approaching Rogue River from the Directions Indicated (National Marine Consultants 1960)

Wave Height ft	Duration hr/yr per Wave Period, sec 4-6	6-8	8-10	10-12	12-14	14-16	16-18	Total
				North				
1-3	454	540	30					1024
3-5	61	161	239	9				470
5-7	2		63	29				94
7-9			2	2				4
Total	517	701	334	40				1592
				North-Northwest				
1-3	273	14	51	71	3			412
3-5	61	398	52	11	10			532
5-7		178	32	8	3			221
7-9		9	200	18				227
9-11			58	16				74
11-13				2				2
13-15				5				5
Total	334	599	393	131	16			1473
				Northwest				
1-3	303	179	495	600	50	18		1645
3-5	30	507	214	103	42	23	4	943
5-7		118	113	106	16	9	4	366
7-9		2	131	27	18	6	4	188
9-11			33	31	18	8	2	92
11-13			3	6	4	2		15
13-15			3	4	4	2		13
15-17			3		4	2		9
17-19								
19-21					4			4
Total	353	806	995	877	160	70	14	3275

(Continued)

(Sheet 1 of 3)

Table 5 (Continued)

Wave Height ft	Duration hr/yr per Wave Period, sec 4–6	6–8	8–10	10–12	12–14	14–16	16–18	Total
				West-Northwest				
1–3	26	191	409	317	76	68	16	1103
3–5	10	229	430	231	111	52	18	1081
5–7		59	177	171	99	30	11	547
7–9		6	66	80	72	7	15	246
9–11		5	20	50	18	27	4	124
11–13			4	23	6	6		39
13–15				13	7	2	2	24
15–17				4	15	2	2	23
17–19					2	2		4
Total	36	490	1106	889	406	196	68	3191
				West				
1–3	121	213	335	312	68	44	37	1130
3–5	24	345	349	184	111	60	24	1097
5–7		77	189	102	54	46	14	482
7–9		4	104	98	52	22	9	289
9–11		2	38	47	23	12	2	124
11–13			9	27	18	6		60
13–15			5	18	15	8		46
15–17				24	11	4	2	41
17–19				4	17	6		27
19–21					4	2		6
21–23					2			2
Total	145	641	1029	816	375	210	88	3304
				West-Southwest				
1–3	26	72	124	81	32	18	6	359
3–5	9	132	113	58	13	11	2	338
5–7		33	50	39	20	11	2	155
7–9		2	74	25	2	6		109
9–11			22	6	6	2		36
11–13			5	8	8			21
13–15				4	2			6
15–17								
17–19					2			2
19–21							2	2
21–23								
23–25					6	2		8
Total	35	239	388	221	91	50	12	1036

(Continued)

(Sheet 2 of 3)

Table 5 (Concluded)

Wave Height ft	Duration hr/yr per Wave Period, sec 4-6	6-8	8-10	10-12	12-14	14-16	16-18	Total
				Southwest				
1-3	214	56	93	110	11	2		486
3-5	32	238	56	16	4	4		350
5-7		65	26	16				107
7-9		4	109	12	2	2	2	131
9-11			20	24	4			48
11-13			7	15	4		2	28
13-15			7	2		2		11
15-17					9			9
Total	246	363	318	195	34	10	4	1170
				South-Southwest				
1-3	41	18	28	54	2	2		145
3-5	17	87	16	6	8			134
5-7		27	8	11	2			48
7-9		2	64	2				68
9-11			21	7				28
11-13			5	12				17
13-15			7	2				9
15-17			5	19	11			35
Total	58	134	154	113	23	2		484
				South				
1-3	313	263	106	30	2	2		716
3-5	80	152	200	2				434
5-7			10	20	5			35
7-9			39	63				102
9-11			7	20				27
11-13			2	35	14			51
Total	393	415	364	170	21	2		1365

Table 6

Shipboard Observations of Shallow-Water Waves (Sea and Swell) Approaching Rogue River from the Directions Indicated

(National Climatic Center 1976)

Wave Height ft	Observations* per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					North				
0-5	2523	3733	1585	379	98	69	10	28	8425
5-7	4933	405	358	162	94	17	2		5971
7-9	1199	101	90	34	30	10	1		1465
9-11		24	21	5	4	7			61
11-13	230	14	11	3	9	4			271
13-15	49	1	5	1	2				58
15-17	13		1	1					15
17-19			1						1
19-21	1								1
21-23									
23-25									
25-27	1								1
Total	8949	4278	2072	585	237	107	13	28	16,269
					North-Northwest				
0-5	1856	327	99	16	103	24	3	33	2461
5-7	3729	2137	724	131	57	35	3	1	6817
7-9		1219	754	163	56	18	3		2213
9-11	938			108	28	7	1	1	1083
11-13	164	343	319	33	12	1			872
13-15			90						90
15-17	33	107	22	5	3	4			174
17-19		19		7	2	1	1		30
19-21	12		15	1	1	1			30
21-23	2	13	7	1					23
23-25		4							4
25-27	1		4	1					6
27-29	1	1	1						3
29-31		2							2
31-33		1							1
Total	6736	4173	2035	466	262	91	11	35	13,809

(Continued)

* Based on total of 131,643 observations from 1950-1975.

(Sheet 1 of 5)

Table 6 (Continued)

Wave Height ft	Observations per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					Northwest				
0-5	1962	489	171	230	20	9	2	28	2911
5-7	3908	2763	1165		90	43	4	19	7992
7-9		1402	1006	240	89	40	6	1	2784
9-11	873		380	147	87		6	1	1494
11-13		401		65		41			507
13-15	167	135	160	14	40	18	3	2	539
15-17	36		38		23				97
17-19		26		17		7	2		52
19-21	11		23	4	9	5			52
21-23		25	6	1	7				39
23-25	5		6		4	3			18
25-27		1				2			3
27-29		2	2						4
29-31			1		2	1			4
31-33		1							1
33-35									
35-37	1								1
Total	6963	5245	2958	718	371	169	23	51	16,498
					West-Northwest				
0-5	1701	497	200	22	32	10	3	4	2469
5-7	3072	2348	1316	231	78	52	2	6	7105
7-9				361	108	39	7		515
9-11	690	1102	1056					2	2850
11-13		397	432	205	124	27	3		1188
13-15	119				68		7		194
15-17	43	109	159	70		26		1	408
17-19		25	36	24	23	12			120
19-21	4				12		3		19
21-23		8	17	17		9			51
23-25	4	2	9	2	5	7	1	1	31
25-27					2		1		3
27-29		2	3			1			6
29-31	3		2		1	1			7
31-33		1							1
33-35		1	3			2			6
35-37				1					1
37-39					1	1			2
Total	5636	4492	3233	933	454	187	27	14	14,976

(Continued)

Table 6 (Continued)

Wave Height ft	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
	Observations per Wave Period, sec								
West									
0-5	1455	510	249	26	55	11	1	21	2328
5-7	2714	2251	1302	239	131	53	2	6	6698
7-9						70	4	3	77
9-11	660	1176	1139	381	122	70	8	3	3559
11-13		435	485	200	135				1255
13-15	157					38	9		204
15-17		224	189	66	77	12	1	1	570
17-19	37		59	18	26				140
19-21	7	38				10	1		56
21-23	2	10	19	20	26	2	1	1	81
23-25			7	9		3	2	2	23
25-27		6			9				15
27-29			3	2	4	6			15
29-31		2	4	3					9
31-33		2			1				3
33-35					1				1
35-37				1					1
37-39									
39-41					1				1
41-43		1							1
Total	5032	4655	3456	965	588	275	29	37	15,037
West-Southwest									
0-5	1314	455	193	18	21		2	9	2012
5-7	2467	1800	905	148	78	25			5423
7-9		939					6	3	948
9-11	576		723	238	79	41	2	1	1660
11-13		369	407	158					934
13-15	149				105	35	3		292
15-17	30	107	148	62	34				381
17-19			53			23	5	2	83
19-21	10	36		17	7	6	3		79
21-23	5	12	24	9	15				65
23-25						5			5
25-27		4	8	2	2				16
27-29			7	1		3	2	2	15
29-31		3			2	1			6
31-33	1		4	2	1				8
33-35							1	1	2
35-37					3	1			4
Total	4552	3725	2472	655	347	140	24	18	11,933

(Continued)

Table 6 (Continued)

Wave Height ft	Observations per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
				Southwest					
0-5	903	213	62	5	8	1	1	11	1204
5-7	1850	1082	379	74	47	11	2	4	3449
7-9			441	129	42	23	2	3	640
9-11	463	652			54	20	1	1	1191
11-13		219	232	78					529
13-15	93		93	45	21	22			274
15-17	35	88		9	9	3			144
17-19			32		9				41
19-21	3	22	18	5					48
21-23	1	15		1	1	3			21
23-25			4		1	5			10
25-27	2	6	2		3				13
27-29		4		2					6
29-31				1		1			2
31-33		1							1
33-35									
35-37	1								1
Total	3351	2302	1264	348	195	89	6	19	7574
				South-Southwest					
0-5	843	155	44	2	15	14		13	1086
5-7	1749	827	273	47					2896
7-9			331	70	27	9	3	2	442
9-11	438	541	176	60	29	16	1	1	1262
11-13	104	267		38	20	10	3		442
13-15			93		12	2			107
15-17	29	71	34	6	8				148
17-19		23	16	5		7	1	1	53
19-21	5		5	2		2			9
21-23	7	4				2	1		14
23-25		4	1	1		1			7
25-27	1		2	2					5
27-29	2	4	1						7
29-31						1			1
31-33									
33-35									
35-37									
37-39	1								1
Total	3179	1896	976	233	111	64	9	17	6485

(Continued)

Table 6 (Concluded)

Wave Height ft	Observations per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					South				
0-5	4503	1221	351	75	59	46	10	21	6286
5-7	802	1274	714	164	66	15	14	5	3054
7-9		143	145	87	36	14			425
9-11	205	38	73	57	17	2			392
11-13	83	15	33	31	18				180
13-15	13	7	21	19	17				77
15-17	8	4	4	4	1				21
17-19	4	6	4	5	1				20
19-21	1	1		3					5
21-23	2		1		1				4
23-25	1								1
Total	5622	2709	1346	445	216	77	24	26	10,465

(Sheet 5 of 5)

Table 7

Estimated Frequencies* of Shallow-Water Waves Approaching

Rogue River from the Directions Indicated

(Fleet Numerical Weather Center)

Wave Height ft	Occurrences per Wave Period, sec								
	<5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					North				
<3	29	54	2	10	1			76	172
3-6	80	50	35	9	1				175
6-9	13	1	16	1					31
Total	122	105	53	20	2			76	378
					North-Northwest				
<3	19	2					1		22
3-6	54	38	6	3	1		1		103
6-9	7	23	7	4	1				42
9-12	1	4	7	4					16
12-15						2			2
Total	81	67	20	11	2	2	2		185
					Northwest				
<3	17	3	1	1	1				23
3-6	45	27	8	3	2	1			86
6-9	5	18	16	10	2	1	1	1	54
9-12	1	3	9	3	1	1	1		19
12-15		1	2	2	3	1	2	1	12
15-18				1				1	2
18-21						1		1	2
21-24						1			1
Total	68	52	36	20	9	6	4	4	199

(Continued)

* Based on 2,798 occurrences from 11 April 1969 - 14 December 1977.

(Sheet 1 of 3)

Table 7 (Continued)

Wave Height ft	Occurrences per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
West-Northwest									
<3	12	1	1				1	1	16
3-6	38	25	12	8	8	8	4		103
6-9	3	23	15	6	9	10	6	9	81
9-12		3	8	4	4	5	4	5	33
12-15			3	2		2	2	1	10
15-18		1		2				1	4
18-21								1	1
21-24					1		1		2
24-27								1	1
Total	53	53	39	22	22	25	18	19	251
West									
<3	21	12	11	13	10	4	3	1	75
3-6	50	37	46	47	31	15	9	4	239
6-9	10	16	28	62	39	11	20	9	195
9-12	3	4	11	51	30	14	8	10	131
12-15	1	1	6	9	26	19	16	8	86
15-18	1	1	3	5	16	4	13	1	44
18-21	1		1	1	5	1	3	2	14
21-24				1	3	2	1	5	12
24-27					1		2		3
27-30									1
Total	87	71	107	189	161	70	75	40	800
West-Southwest									
<3	7	3	1	1					12
3-6	32	19	8	8	6	2	4	1	80
6-9	2	14	12	11	8	5	3	2	57
9-12	3	5	8	12	7	1	4	2	42
12-15	2	1	4	6	7	4	2	2	28
15-18			3	5	11	3	2		24
18-21				2	4	2			8
21-24				1		1	1	1	4
24-27				1	1	1		1	4
27-30						2	1		3
30-33							1		1
Total	46	42	36	47	44	21	18	9	263

(Continued)

(Sheet 2 of 3)

Table 7 (Concluded)

Wave Height ft	Occurrences per Wave Period, sec <5	5-7	7-9	9-11	11-13	13-15	15-17	>17	Total
					Southwest				
<3	12	3	6	6	2	1			30
3-6	27	15	11	7	5	1	2	1	69
6-9	7	15	8	12	5	8	1		56
9-12	1	5	11	13	9	6	7	2	54
12-15		2	3	18	4	1	2		30
15-18			1	2	3	1	2		9
18-21				1	3	1	1		6
21-24					1	1		1	3
Total	47	40	40	59	32	20	15	4	257
					South-Southwest				
<3	14	4	2						20
3-6	18	14	7	3	2	3	1		48
6-9	7	17	19	2	3		1		49
9-12	1	4	20	26	4	1			56
12-15	1	1	1	8	7	1	1		20
15-18		1	1	5	2	3	1		13
18-21					1	1	1		3
21-24						1	2	2	5
Total	41	41	50	44	19	10	7	2	214
					South				
<3	16	1	2	1	2	2		1	25
3-6	21	39	27	9	6	1	2	4	109
6-9	9	7	24	34	10	3	3		90
9-12	1	2	1	13	5	1			23
12-15				3	1				4
Total	47	49	54	60	24	7	5	5	251

(Sheet 3 of 3)

TABLE 8

WAVE HEIGHTS FOR BASE TEST 1 FOR TEST WAVES

FROM NORTH-NORTHWEST AND WEST, SWL = +6.7 FT

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft Gage 1	Gage 2	Gage 3	Gage 4	Gage 5	Gage 6	Gage 7	Gage 8
NNW	5.0	7.0	5.1	5.1	6.3	0.7	0.2	0.1	<0.1	0.1
		12.0	8.3	9.1	7.0	1.1	0.3	0.2	0.2	0.2
	9.0	7.0	6.3	9.4	8.4	1.5	0.3	0.2	0.2	0.3
		12.0	19.2	15.5	11.3	1.7	0.9	0.7	0.5	1.3
		17.0	19.6	14.6	12.7	2.4	0.8	0.6	0.4	0.5
		27.0	18.8	13.7	9.5	1.9	0.9	0.7	0.4	0.7
	13.0	7.0	5.9	12.8	11.2	2.2	0.6	0.4	0.3	0.5
		13.0	15.4	15.1	10.6	1.5	1.0	0.9	0.6	0.4
		21.0	17.9	17.3	11.8	2.0	0.9	0.6	0.4	0.5
	17.0	7.0	7.4	13.2	14.8	3.5	1.4	1.1	0.8	0.5
		11.0	16.1	14.3	11.4	1.2	0.9	0.9	0.7	0.5
W	5.0	7.0	7.7	7.3	6.1	0.8	0.6	0.5	0.3	0.3
		12.0	7.8	8.1	6.6	1.3	0.5	0.4	0.3	0.4
	9.0	7.0	6.0	5.3	9.1	2.4	0.4	0.6	0.4	0.5
		12.0	10.9	11.4	7.6	2.3	0.8	0.7	0.4	1.0
		23.0	15.9	14.5	12.1	3.0	1.5	1.9	1.0	0.9
		31.0	14.2	11.1	10.8	3.2	1.5	1.8	0.8	1.2
	13.0	7.0	8.0	5.9	11.4	3.0	1.1	0.7	0.4	0.4
		12.0	13.0	14.4	10.3	3.6	1.4	1.3	0.8	0.7
		21.0	19.6	14.7	10.6	3.0	1.6	1.1	0.9	0.7
		29.0	18.2	13.9	9.9	3.9	1.3	1.2	0.6	0.7
	17.0	7.0	6.8	8.6	13.3	3.1	1.5	0.7	0.4	0.5
		12.0	11.2	18.5	14.0	3.8	1.9	1.1	0.8	0.7
		17.0	18.2	15.7	13.8	2.6	1.4	1.1	0.8	0.8
		25.0	23.1	16.0	12.3	3.1	1.8	1.7	1.0	1.2

(CONTINUED)

TABLE 8 (CONCLUDED)

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft: Gage 9	Gage 10	Gage 11	Gage 12	Gage 13	Gage 14	Gage 15
NNW	5.0	7.0	<0.1	<0.1	0.1	0.2	<0.1	<0.1	<0.1
		12.0	0.2	0.1	0.3	0.3	<0.1	<0.1	<0.1
	9.0	7.0	0.2	0.1	0.4	0.5	0.1	0.1	0.1
		12.0	0.7	0.4	1.5	0.9	0.2	0.2	0.2
		17.0	0.4	0.3	0.7	1.3	0.2	0.2	0.2
		27.0	0.5	0.4	1.0	1.5	0.2	0.2	0.2
	13.0	7.0	0.4	0.4	0.6	1.1	0.3	0.1	0.2
		13.0	0.6	0.5	1.0	1.2	0.3	0.2	0.2
		21.0	0.5	0.5	0.8	1.8	0.3	0.2	0.3
	17.0	7.0	0.9	0.9	1.0	0.7	0.1	0.1	0.1
		11.0	0.8	0.9	0.8	0.9	0.2	0.1	0.2
W	5.0	7.0	0.2	<0.1	0.2	0.4	<0.1	<0.1	<0.1
		12.0	0.5	0.2	0.5	0.4	<0.1	<0.1	<0.1
	9.0	7.0	0.6	0.5	0.5	0.5	0.1	<0.1	0.1
		12.0	0.4	0.4	0.7	0.4	0.2	<0.1	0.2
		23.0	0.6	0.8	1.0	1.2	0.3	0.1	0.2
		31.0	1.1	1.0	1.5	1.3	0.3	0.1	0.3
	13.0	7.0	0.4	0.4	0.7	1.0	0.2	<0.1	0.2
		12.0	0.8	0.7	1.0	1.0	0.2	0.1	0.2
		21.0	0.8	1.0	1.3	1.9	0.3	0.2	0.3
		29.0	0.5	0.9	1.0	1.8	0.3	0.2	0.3
	17.0	7.0	0.4	0.5	0.7	1.1	0.2	0.1	0.1
		12.0	0.6	0.7	0.8	2.1	0.3	0.2	0.2
		17.0	0.9	0.8	1.3	2.0	0.3	0.2	0.3
		25.0	1.1	1.1	1.5	2.6	0.4	0.3	0.6

TABLE 9

WAVE HEIGHTS FOR BASE TEST 1 FOR TEST WAVES

FROM SOUTHWEST AND SOUTH-SOUTHWEST, SWL = +6.7 FT

TEST WAVE			WAVE HEIGHT, FT				
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 1	GAGE 2	GAGE 3	GAGE 4	GAGE 5
SW	5.0	7.0	8.2	9.5	8.9	2.3	1.8
		12.0	9.0	9.0	7.3	1.8	0.8
	7.0	7.0	6.6	7.9	8.2	1.3	1.4
		12.0	11.6	11.7	10.5	3.7	2.4
		20.0	16.8	11.9	10.5	2.7	0.8
	9.0	7.0	5.9	6.3	5.8	2.9	0.6
		13.0	11.8	13.3	8.9	2.3	1.1
		21.0	24.7	14.2	9.8	1.9	1.5
		27.0	20.1	17.6	11.6	3.1	1.5
	11.0	7.0	7.7	7.6	9.6	2.9	1.5
		13.0	17.9	17.2	9.2	1.7	0.7
		21.0	21.4	17.9	11.9	2.6	1.4
		29.0	21.6	19.1	11.3	2.4	1.0
	13.0	7.0	7.6	7.4	13.6	2.9	1.1
		13.0	18.5	17.9	10.9	1.8	0.9
		21.0	17.7	15.6	13.7	4.2	1.5
		27.0	24.6	17.9	11.5	2.8	1.1
	15.0	7.0	6.9	5.5	9.4	2.4	1.1
		12.0	17.9	15.2	10.3	2.1	1.4
		17.0	21.6	17.7	10.7	2.0	1.2
		25.0	22.5	21.6	11.8	3.9	1.9
	17.0	7.0	7.9	5.9	10.4	3.2	1.2
		12.0	12.9	16.5	9.8	3.0	1.3
		18.0	22.3	15.3	11.6	3.0	1.2
SSW	5.0	7.0	6.3	7.8	6.3	2.0	2.0
		12.0	10.2	9.3	7.9	1.8	1.2
	9.0	7.0	9.3	9.2	11.8	3.0	0.8
		12.0	14.2	16.0	9.2	1.6	1.7
		17.0	18.7	15.4	11.3	2.2	1.0
		27.0	16.9	15.6	11.8	1.8	1.0
	13.0	7.0	10.6	13.2	11.6	5.4	2.6
		12.0	18.4	19.2	9.9	1.8	0.8
		21.0	18.6	18.4	12.3	2.6	1.2
	17.0	7.0	12.2	14.2	12.0	4.2	1.7
		12.0	24.1	18.1	11.6	2.6	1.3
		18.0	21.7	16.1	13.5	3.2	1.3

(CONTINUED)

TABLE 9 (CONTINUED)

TEST WAVE			WAVE HEIGHT, FT				
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10
SW	5.0	7.0	1.5	0.9	0.8	0.8	0.3
		12.0	0.6	0.3	0.5	0.3	0.3
	7.0	7.0	1.1	0.8	0.3	0.8	0.5
		12.0	1.2	0.7	0.9	1.7	0.6
		20.0	0.7	0.7	0.7	1.0	0.7
	9.0	7.0	0.9	0.8	0.4	0.6	0.6
		13.0	0.8	0.5	0.9	0.6	0.8
		21.0	1.2	0.6	0.6	0.6	0.8
		27.0	1.6	0.8	0.8	0.5	0.8
	11.0	7.0	0.9	0.5	0.4	0.3	0.2
		13.0	1.0	0.6	0.5	0.4	0.5
		21.0	1.5	0.9	0.7	0.6	0.5
		29.0	1.0	0.6	0.7	0.7	0.7
	13.0	7.0	0.8	0.7	0.6	0.4	0.4
		13.0	0.9	0.5	0.5	0.5	0.7
		21.0	1.2	0.9	0.8	1.0	1.3
		27.0	0.9	0.6	0.7	0.7	0.8
	15.0	7.0	0.5	0.4	0.4	0.4	0.5
		12.0	1.0	0.6	0.6	0.5	0.6
		17.0	0.9	0.5	0.5	0.5	0.7
		25.0	1.3	0.7	0.9	1.2	1.2
	17.0	7.0	0.7	0.4	0.5	0.4	0.5
		12.0	1.1	0.7	0.6	0.5	0.8
		18.0	1.0	0.7	0.6	0.6	0.7
SSW	5.0	7.0	1.3	0.4	0.5	0.3	0.3
		12.0	0.7	0.4	0.5	0.4	0.2
	9.0	7.0	0.8	0.4	0.8	0.5	0.4
		12.0	1.0	0.7	0.6	0.4	0.7
		17.0	0.8	0.5	0.8	0.4	0.5
		27.0	1.2	0.8	1.0	0.7	0.7
	13.0	7.0	1.7	1.3	1.1	0.9	0.7
		12.0	0.7	0.4	0.6	0.7	0.8
		21.0	1.1	0.6	0.7	0.7	0.8
	17.0	7.0	1.5	1.0	1.0	1.1	1.1
		12.0	1.2	0.8	0.7	0.7	0.9
		18.0	1.0	0.6	0.7	0.7	0.9

(CONTINUED)

TABLE 9 (CONCLUDED)

Test Wave Direction	Test Wave Period sec	Test Wave Height ft	Wave Height, ft Gage 11	Gage 12	Gage 13	Gage 14	Gage 15
SW	5.0	7.0	0.7	0.9	<0.1	<0.1	0.1
		12.0	0.6	0.8	<0.1	<0.1	0.1
	7.0	7.0	0.7	0.5	0.1	<0.1	0.1
		12.0	1.9	1.4	0.2	0.1	0.3
		20.0	1.2	1.1	0.1	0.1	0.2
	9.0	7.0	0.6	0.4	<0.1	<0.1	<0.1
		13.0	0.8	0.4	<0.1	<0.1	0.1
		21.0	0.9	0.6	0.2	<0.1	0.1
		27.0	1.1	1.5	0.2	0.1	0.3
	11.0	7.0	0.6	0.8	0.1	<0.1	<0.1
		13.0	0.7	1.0	0.2	0.1	0.2
		21.0	1.0	1.7	0.2	0.1	0.2
		29.0	0.7	1.1	0.2	0.2	0.2
	13.0	7.0	1.0	1.2	0.2	<0.1	0.1
		13.0	0.8	1.6	0.2	0.1	0.2
		21.0	1.4	3.2	0.3	0.2	0.4
		27.0	0.9	2.6	0.4	0.2	0.3
	15.0	7.0	0.7	1.1	0.2	0.1	0.2
		12.0	0.7	1.9	0.2	0.1	0.2
		17.0	0.7	1.4	0.3	0.2	0.2
		25.0	1.3	3.3	0.4	0.3	0.5
	17.0	7.0	0.7	1.1	0.2	0.1	0.1
		12.0	0.8	2.4	0.3	0.2	0.3
		18.0	0.8	1.8	0.3	0.2	0.3
SSW	5.0	7.0	0.5	0.7	<0.1	<0.1	0.1
		12.0	0.8	0.6	<0.1	<0.1	0.1
	9.0	7.0	0.7	0.9	0.1	<0.1	0.2
		12.0	0.7	0.7	0.1	<0.1	0.2
		17.0	0.8	0.8	0.1	0.1	0.2
		27.0	0.9	1.1	0.2	<0.1	0.2
	13.0	7.0	1.1	1.7	0.2	0.1	0.3
		12.0	0.9	1.2	0.2	0.1	0.2
		21.0	0.9	2.5	0.3	0.2	0.3
	17.0	7.0	1.1	1.8	0.2	0.2	0.3
		12.0	0.9	2.1	0.2	0.2	0.2
		18.0	1.0	2.3	0.2	0.2	0.2

(SHEET 3 OF 3)

TABLE 10

WAVE HEIGHTS FOR BASE TEST 1 TIDAL FLOW CONDITIONS

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft: Gage 1	Gage 2	Gage 3	Gage 4	Gage 5
			SWL = +1.5 FT (MAXIMUM EBB)				
SW	5.0	7.0	8.4	7.4	5.5	1.5	<0.1
		12.0	9.1	8.2	5.4	0.5	<0.1
	7.0	7.0	7.2	8.3	7.6	1.0	0.1
		12.0	13.3	13.7	6.5	0.8	0.1
		20.0	17.9	10.0	8.8	1.0	0.1
	9.0	7.0	6.1	7.6	10.2	0.6	<0.1
		13.0	13.3	13.4	6.5	0.8	<0.1
		21.0	15.5	13.2	8.0	1.2	0.1
		27.0	15.4	14.2	9.1	1.3	0.2
	11.0	7.0	7.6	8.0	9.3	1.2	0.2
		13.0	20.8	13.8	8.4	1.2	0.2
		21.0	18.5	14.4	9.0	1.2	0.3
		29.0	19.2	14.4	9.1	1.4	0.3
	13.0	7.0	7.0	8.5	9.2	0.8	0.2
		13.0	18.5	13.1	8.1	1.3	0.3
		21.0	14.1	14.8	10.2	1.8	0.4
		27.0	22.1	15.5	9.5	1.9	0.4
	15.0	7.0	9.6	7.6	8.2	1.4	0.3
		12.0	18.8	13.8	8.6	1.2	0.4
		17.0	17.3	15.0	10.6	2.0	0.4
		25.0	20.0	16.5	11.5	1.8	0.6
	17.0	7.0	8.0	10.5	8.8	1.3	0.4
		12.0	15.8	17.8	9.8	1.2	0.3
		18.0	14.6	14.8	12.1	1.7	0.5
			SWL = +4.3 FT (MAXIMUM FLOOD)				
	5.0	7.0	9.0	8.2	7.5	1.0	0.4
		12.0	8.8	8.4	7.2	1.1	0.5
	7.0	7.0	6.3	6.3	6.0	0.9	0.7
		12.0	11.6	12.5	8.5	2.2	1.3
		20.0	11.5	15.8	9.5	1.4	0.5
	9.0	7.0	7.7	6.9	10.6	2.0	0.5
		13.0	13.6	13.8	8.0	0.7	0.2
		21.0	16.4	12.3	9.9	1.3	0.4
		27.0	17.5	17.0	11.1	2.2	0.7
	11.0	7.0	6.7	8.2	10.0	1.7	0.6
		13.0	18.7	14.1	9.9	1.3	0.3
		21.0	17.4	17.3	10.5	1.0	0.6
		29.0	17.7	16.9	10.0	1.7	0.6
	13.0	7.0	7.8	9.2	10.5	1.9	1.3
		13.0	20.1	18.2	9.9	1.1	0.4
		21.0	20.6	14.0	10.8	1.6	0.6
		27.0	18.5	15.4	11.5	2.6	0.9
	15.0	7.0	7.7	5.7	10.8	1.5	0.6
		12.0	19.1	17.1	8.5	1.0	0.2
		17.0	16.8	12.4	8.5	1.1	0.8
		25.0	22.2	16.3	10.6	2.1	0.9
	17.0	7.0	6.0	8.4	10.5	1.5	0.7
		12.0	15.9	17.4	7.7	1.3	0.5
		18.0	15.2	13.1	10.0	1.8	0.6

(CONTINUED)

TABLE 10 (CONTINUED)

TEST WAVE			WAVE HEIGHT, FT				
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10
			SWL = +1.5 FT(MAXIMUM EBB)				
SW	5.0	7.0	<0.1	<0.1	<0.1	<0.1	<0.1
		12.0	<0.1	<0.1	<0.1	<0.1	<0.1
	7.0	7.0	<0.1	<0.1	0.1	<0.1	<0.1
		12.0	<0.1	<0.1	<0.1	<0.1	<0.1
		20.0	<0.1	<0.1	<0.1	<0.1	<0.1
	9.0	7.0	<0.1	<0.1	<0.1	<0.1	<0.1
		13.0	<0.1	<0.1	<0.1	<0.1	<0.1
		21.0	0.1	<0.1	<0.1	<0.1	<0.1
		27.0	0.1	0.1	0.1	0.1	<0.1
	11.0	7.0	0.1	<0.1	0.1	<0.1	<0.1
		13.0	0.1	<0.1	0.2	<0.1	<0.1
		21.0	0.2	0.1	0.1	0.1	0.1
		29.0	0.2	0.2	0.1	0.1	0.1
	13.0	7.0	0.1	<0.1	0.1	<0.1	<0.1
		13.0	0.2	0.1	0.2	0.1	0.1
		21.0	0.3	0.3	0.3	0.2	0.2
		27.0	0.3	0.2	0.3	0.2	0.2
	15.0	7.0	0.2	0.1	0.2	0.1	0.1
		12.0	0.2	0.1	0.2	0.2	0.1
		17.0	0.3	0.2	0.3	0.2	0.2
		25.0	0.4	0.3	0.3	0.2	0.2
	17.0	7.0	0.3	0.2	0.3	0.2	0.1
		12.0	0.3	0.2	0.2	0.1	0.1
		18.0	0.[illegible]	0.2	0.2	0.2	0.1
			SWL = +4.3 FT(MAXIMUM FLOOD)				
	5.0	7.0	0.2	0.1	0.1	<0.1	0.1
		12.0	0.2	0.1	0.1	0.1	0.1
	7.0	7.0	0.2	0.1	0.2	0.1	0.1
		12.0	1.0	0.6	0.4	0.4	0.5
		20.0	0.2	0.2	0.2	0.4	0.2
	9.0	7.0	0.2	0.1	0.2	0.1	0.2
		13.0	0.1	0.1	0.2	0.2	0.2
		21.0	0.3	0.2	0.3	0.3	0.3
		27.0	0.3	0.2	0.3	0.4	0.3
	11.0	7.0	0.2	0.2	0.2	<0.1	0.2
		13.0	0.2	0.2	0.1	0.2	0.2
		21.0	0.5	0.2	0.2	0.3	0.4
		29.0	0.4	0.2	0.3	0.3	0.3
	13.0	7.0	0.4	0.3	0.2	0.2	0.3
		13.0	0.3	0.2	0.2	0.2	0.2
		21.0	0.4	0.3	0.3	0.3	0.4
		27.0	0.4	0.3	0.4	0.4	0.4
	15.0	7.0	0.3	0.2	0.2	0.2	0.2
		12.0	0.1	0.1	0.2	0.2	0.2
		17.0	0.4	0.3	0.3	0.4	0.4
		25.0	0.6	0.3	0.5	0.4	0.4
	17.0	7.0	0.3	0.2	0.2	0.2	0.2
		12.0	0.2	0.2	0.3	0.3	0.3
		18.0	0.5	0.3	0.3	0.3	0.4

(CONTINUED)

TABLE 10 (CONCLUDED)

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft: Gage 11	Gage 12	Gage 13	Gage 14	Gage 15
			SWL = +1.5 FT(MAXIMUM EBB)				
SW	5.0	7.0	<0.1	<0.1	<0.1	<0.1	<0.1
		12.0	<0.1	<0.1	<0.1	<0.1	<0.1
	7.0	7.0	<0.1	0.1	<0.1	<0.1	<0.1
		12.0	0.1	<0.1	<0.1	<0.1	<0.1
		20.0	0.2	<0.1	<0.1	<0.1	<0.1
	9.0	7.0	<0.1	<0.1	<0.1	<0.1	<0.1
		13.0	0.1	<0.1	<0.1	<0.1	<0.1
		21.0	0.1	<0.1	<0.1	<0.1	<0.1
		27.0	0.3	0.1	<0.1	0.1	<0.1
	11.0	7.0	0.1	0.1	<0.1	<0.1	<0.1
		13.0	0.2	0.2	<0.1	<0.1	<0.1
		21.0	0.2	0.2	<0.1	<0.1	<0.1
		29.0	0.2	0.2	<0.1	<0.1	<0.1
	13.0	7.0	0.2	0.2	<0.1	<0.1	<0.1
		13.0	0.3	0.3	<0.1	<0.1	<0.1
		21.0	0.5	0.4	0.1	0.1	0.2
		27.0	0.3	0.4	<0.1	<0.1	0.1
	15.0	7.0	0.3	0.3	<0.1	<0.1	<0.1
		12.0	0.4	0.4	<0.1	<0.1	<0.1
		17.0	0.4	0.4	<0.1	<0.1	<0.1
		25.0	0.4	0.5	<0.1	<0.1	0.1
	17.0	7.0	0.4	0.4	<0.1	<0.1	<0.1
		12.0	0.3	0.5	<0.1	<0.1	<0.1
		18.0	0.3	0.3	<0.1	<0.1	<0.1
			SWL = +4.3 FT(MAXIMUM FLOOD)				
	5.0	7.0	0.3	0.4	<0.1	<0.1	0.1
		12.0	0.4	0.6	<0.1	<0.1	0.1
	7.0	7.0	0.3	0.6	<0.1	<0.1	<0.1
		12.0	0.4	1.4	<0.1	<0.1	0.2
		20.0	0.4	0.6	<0.1	<0.1	<0.1
	9.0	7.0	0.3	1.0	0.1	<0.1	0.1
		13.0	0.2	0.4	<0.1	<0.1	<0.1
		21.0	0.4	0.9	0.1	<0.1	0.2
		27.0	0.4	1.7	0.1	0.1	0.4
	11.0	7.0	0.4	0.6	<0.1	<0.1	<0.1
		13.0	0.4	1.0	0.1	<0.1	0.1
		21.0	0.7	1.1	0.2	0.1	0.2
		29.0	0.5	1.2	0.2	0.1	0.2
	13.0	7.0	0.5	0.8	0.1	<0.1	0.1
		13.0	0.5	0.6	0.1	0.1	0.1
		21.0	0.6	1.3	0.2	0.1	0.2
		27.0	0.7	1.7	0.3	0.2	0.4
	15.0	7.0	0.4	0.9	<0.1	<0.1	<0.1
		12.0	0.3	0.6	0.1	<0.1	0.1
		17.0	0.9	1.0	0.1	0.1	0.2
		25.0	0.7	1.3	0.2	0.2	0.3
	17.0	7.0	0.4	0.8	<0.1	<0.1	<0.1
		12.0	0.5	0.9	0.1	0.1	0.1
		18.0	0.9	1.2	0.2	0.1	0.2

(SHEET 3 OF 3)

Table 11

Water-Surface Elevations, Base Test 1

Discharge cfs	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Water-Surface Elevation* at Indicated Station, ft								
				swl = 0.0 ft					
50,000	0.0	0.0	0.7	0.9	0.9	1.0	1.0	1.1	1.2
100,000	0.0	0.0	2.8	3.2	3.4	3.5	3.5	3.7	4.0
150,000	0.0	0.0	5.3	5.9	6.0	6.1	6.1	6.3	6.7
200,000	0.0	0.0	7.4	8.1	8.3	8.4	8.4	8.5	9.1
250,000	0.3	1.5	9.2	10.1	10.3	10.4	10.4	10.6	11.2
300,000	0.9	2.9	10.8	11.8	12.1	12.2	12.2	12.3	13.1
350,000	1.1	4.0	12.4	13.5	13.9	14.0	14.0	14.1	15.0
				swl = +6.7 ft					
50,000	6.7	6.7	6.8	6.9	6.9	6.9	6.9	6.9	7.0
100,000	6.7	6.7	7.2	7.4	7.5	7.5	7.5	7.5	7.7
150,000	6.7	6.7	7.8	8.2	8.4	8.4	8.4	8.4	8.8
200,000	6.7	6.7	8.8	9.3	9.6	9.6	9.6	9.7	10.2
250,000	6.7	6.7	9.9	10.7	11.0	11.0	11.0	11.2	11.8
300,000	6.7	6.7	11.1	12.0	12.5	12.5	12.5	12.6	13.4
350,000	6.7	6.7	12.5	13.6	14.1	14.1	14.1	14.2	15.2

*Elevation referenced to mllw.

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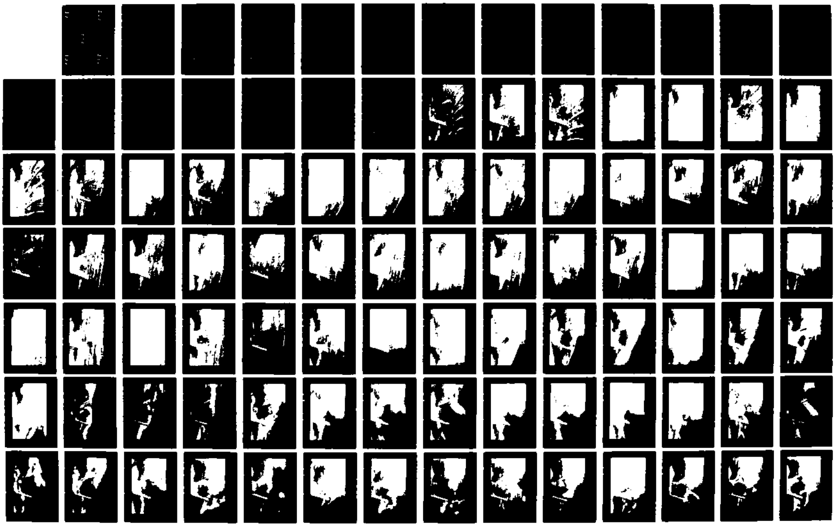

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table 12

River Current Velocities Obtained for Base Test 1

Discharge cfs	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Velocity at Indicated Station, fps								
				swl = 0.0 ft					
50,000	5.7	5.4	3.9	2.6	1.5	1.5	3.0	3.3	2.4
100,000	12.5	13.6	7.0	4.3	3.1	3.1	5.1	5.3	3.8
150,000	20.0	20.0	7.9	5.6	3.4	4.3	5.9	7.0	4.1
200,000	23.0	21.4	9.0	6.2	5.0	5.4	6.7	7.1	5.0
250,000	27.3	26.0	9.5	7.0	5.7	6.1	7.1	7.7	5.5
300,000	30.0	30.0	10.7	7.5	6.3	7.3	7.9	9.1	5.8
350,000	33.3	30.0	11.5	8.0	6.7	7.8	8.3	9.4	6.0
				swl = +6.7 ft					
50,000	3.1	3.2	2.4	1.7	1.2	1.3	1.8	2.1	1.5
100,000	6.1	6.5	4.5	3.3	2.6	3.0	3.8	3.9	2.9
150,000	10.0	10.0	6.3	4.8	3.8	3.9	5.0	5.6	4.0
200,000	12.5	12.5	8.1	5.8	4.7	5.0	6.3	6.9	4.5
250,000	16.7	16.7	9.1	6.8	5.5	6.2	7.1	7.4	5.3
300,000	18.9	18.9	10.0	7.5	6.3	7.5	7.9	8.7	5.8
350,000	23.0	23.0	11.1	7.9	7.0	7.6	8.6	9.1	6.0

TABLE 13

WAVE HEIGHTS FOR BASE TEST 2 FOR TEST WAVES

FROM NORTH-NORTHWEST AND WEST, SWL = +6.7 FT

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft: Gage 1	Gage 2	Gage 3	Gage 4	Gage 5	Gage 6	Gage 7	Gage 8
NNW	5.0	7.0	7.8	7.7	6.5	0.4	0.2	0.2	0.1	0.2
		12.0	7.4	7.7	7.3	0.7	0.3	0.3	0.2	0.2
	9.0	7.0	7.0	10.2	9.0	1.2	0.2	0.3	0.2	0.3
		12.0	19.0	13.7	12.4	3.5	1.6	1.0	0.5	0.9
		17.0	20.1	16.0	11.1	3.6	1.3	0.9	0.6	0.6
		27.0	20.3	15.8	11.5	3.5	1.8	1.4	0.6	0.8
	13.0	7.0	4.4	13.3	9.1	4.5	1.4	0.8	0.4	0.5
		13.0	20.5	18.8	11.5	3.3	2.2	1.5	0.4	0.9
		21.0	20.2	18.3	10.7	4.9	1.7	1.6	0.6	0.8
	17.0	7.0	5.8	14.2	11.8	2.9	2.3	0.9	0.4	0.6
		11.0	14.9	18.2	13.1	2.7	2.3	1.2	0.8	1.1
W	5.0	7.0	7.6	6.7	7.4	0.5	0.5	1.4	1.0	0.6
		12.0	9.7	8.4	8.1	1.5	1.1	0.8	0.7	0.8
	9.0	7.0	8.3	7.4	9.5	2.1	2.2	1.6	0.6	0.8
		12.0	13.6	13.3	11.2	3.0	1.7	1.0	0.7	0.7
		23.0	15.3	16.8	10.6	3.7	2.6	2.2	1.3	2.6
		31.0	20.4	14.9	12.6	4.6	3.2	2.3	1.4	2.3
	13.0	7.0	8.6	6.8	11.6	3.3	2.2	2.0	1.0	0.8
		12.0	14.2	16.8	9.8	3.2	2.4	1.9	0.8	1.2
		21.0	26.4	14.6	13.3	7.2	3.4	2.2	1.4	1.7
		29.0	23.4	18.8	13.2	5.6	2.1	1.9	1.0	1.6
	17.0	7.0	8.1	7.8	12.4	2.8	3.9	1.7	1.1	1.7
		12.0	13.8	17.5	11.0	4.0	2.4	1.5	1.0	1.5
		17.0	21.9	15.4	10.9	3.2	2.1	1.3	1.2	1.7
		25.0	23.9	16.6	15.3	4.0	3.9	2.8	1.9	1.9

(CONTINUED)

TABLE 13 (CONCLUDED)

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft: Gage 9	Gage 10	Gage 11	Gage 12	Gage 13	Gage 14	Gage 15
NNW	5.0	7.0	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
		12.0	0.2	0.1	0.3	0.1	<0.1	<0.1	<0.1
	9.0	7.0	0.3	0.3	0.4	0.5	<0.1	<0.1	0.2
		12.0	0.7	0.7	1.9	0.9	0.2	0.2	0.2
		17.0	0.4	0.4	1.5	0.8	0.2	0.2	0.2
		27.0	1.0	0.9	1.8	1.1	0.2	0.2	0.3
	13.0	7.0	0.4	0.6	1.0	0.8	0.2	<0.1	0.3
		13.0	0.7	0.9	1.7	0.8	0.2	0.1	0.3
		21.0	0.7	1.0	1.3	1.0	0.3	0.2	0.3
	17.0	7.0	0.9	0.9	1.4	0.7	0.1	0.1	0.1
		11.0	1.4	1.7	2.0	0.7	0.2	0.2	0.1
W	5.0	7.0	0.2	0.2	0.6	0.1	<0.1	<0.1	<0.1
		12.0	0.7	0.7	0.9	0.5	<0.1	<0.1	<0.1
	9.0	7.0	0.9	0.6	1.6	0.7	<0.1	<0.1	0.2
		12.0	0.7	0.7	1.4	0.5	<0.1	<0.1	0.1
		23.0	1.1	1.3	1.7	1.4	0.3	0.1	0.3
		31.0	1.6	1.7	2.6	1.5	0.3	0.2	0.3
	13.0	7.0	0.5	0.9	2.2	0.9	0.2	<0.1	0.2
		12.0	0.8	1.4	2.7	1.0	0.2	0.2	0.3
		21.0	1.5	2.3	3.0	1.3	0.4	0.3	0.3
		29.0	1.0	1.6	1.9	1.6	0.4	0.3	0.4
	17.0	7.0	1.4	2.7	2.8	0.9	0.2	0.2	0.2
		12.0	1.2	1.8	2.2	1.1	0.2	0.2	0.2
		17.0	1.5	2.0	2.4	0.8	0.2	0.2	0.2
		2[illegible]	1.9	2.5	3.3	1.1	0.3	0.2	0.2

TABLE 14

WAVE HEIGHTS FOR BASE TEST 2 FOR TEST WAVES

FROM SOUTHWEST AND SOUTH-SOUTHWEST, SWL = +6.7 FT

Test Wave			Wave Height, ft				
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 1	GAGE 2	GAGE 3	GAGE 4	GAGE 5
SW	5.0	7.0	5.5	7.2	7.8	2.0	1.8
		12.0	7.8	10.4	8.1	2.2	1.6
	7.0	7.0	5.2	9.1	9.3	1.1	2.3
		12.0	11.4	16.1	14.5	7.9	3.8
		20.0	19.3	15.2	14.4	4.7	2.6
	9.0	7.0	6.7	8.0	7.8	1.9	2.4
		13.0	15.0	19.2	9.7	3.4	3.6
		21.0	20.8	22.1	11.0	4.8	2.8
		27.0	25.0	18.8	13.3	5.4	2.5
	11.0	7.0	6.0	9.3	8.2	2.5	3.0
		13.0	18.2	18.6	12.3	3.3	2.9
		21.0	19.2	16.8	13.9	5.1	3.5
		29.0	23.3	21.6	14.5	5.1	3.1
	13.0	7.0	7.1	11.1	15.0	4.6	3.4
		13.0	17.9	18.5	11.9	2.9	3.3
		21.0	15.7	17.7	11.9	4.7	4.1
		27.0	21.8	20.8	17.0	5.3	3.9
	15.0	7.0	6.7	10.1	12.1	2.1	3.0
		12.0	12.8	18.4	12.9	3.3	3.5
		17.0	18.8	18.4	10.1	3.8	3.4
		25.0	23.5	18.1	13.7	4.3	3.4
	17.0	7.0	9.1	11.1	9.1	2.3	3.1
		12.0	15.2	18.5	14.1	5.7	3.3
		18.0	27.3	19.0	12.7	5.2	3.9
SSW	5.0	7.0	6.4	8.0	7.4	2.8	1.9
		12.0	9.5	10.0	7.7	3.0	1.3
	9.0	7.0	8.3	9.9	12.7	3.8	2.8
		12.0	14.2	17.5	9.2	3.1	1.9
		17.0	27.0	15.1	12.1	3.1	1.9
		27.0	23.5	17.6	12.4	3.5	2.3
	13.0	7.0	12.0	15.2	12.5	4.6	3.6
		12.0	22.1	19.0	11.0	3.0	2.1
		21.0	20.6	17.8	12.3	4.7	3.1
	17.0	7.0	11.3	12.1	14.1	7.5	3.3
		12.0	20.6	21.1	10.8	3.6	2.6
		18.0	22.4	15.7	12.2	3.6	3.4

(CONTINUED)

TABLE 14 (CONTINUED)

TEST WAVE			WAVE HEIGHT, FT				
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10
SW	5.0	7.0	2.0	1.3	1.6	1.0	1.4
		12.0	1.8	1.1	2.0	1.7	1.4
	7.0	7.0	1.9	0.8	0.6	0.9	1.7
		12.0	2.6	1.9	2.4	5.5	1.9
		20.0	3.2	1.4	3.0	3.0	2.2
	9.0	7.0	3.6	1.2	1.4	1.1	1.5
		13.0	3.3	1.0	2.1	1.1	1.6
		21.0	4.1	1.0	3.2	1.7	1.4
		27.0	2.0	0.9	3.5	2.2	1.8
	11.0	7.0	5.0	1.7	1.1	1.2	2.3
		13.0	4.8	1.6	1.5	1.3	2.6
		21.0	4.6	1.8	1.8	1.9	2.2
		29.0	2.5	0.9	2.4	1.6	1.8
	13.0	7.0	3.6	1.5	1.4	1.5	2.4
		13.0	4.4	0.9	1.2	1.2	1.9
		21.0	5.5	2.2	2.1	3.2	3.7
		27.0	5.1	1.5	2.5	2.7	2.4
	15.0	7.0	4.0	1.3	1.5	1.6	3.2
		12.0	4.1	1.4	1.6	1.8	3.1
		17.0	3.4	1.1	1.6	1.8	1.7
		25.0	4.3	1.3	1.6	2.3	2.3
	17.0	7.0	2.6	1.2	2.1	2.4	3.3
		12.0	3.1	1.6	2.8	2.5	3.3
		18.0	3.6	1.7	2.4	2.9	3.4
SSW	5.0	7.0	1.1	0.9	1.4	1.2	0.8
		12.0	1.2	0.9	1.5	1.3	0.6
	9.0	7.0	2.2	1.0	2.6	1.3	1.7
		12.0	2.3	0.9	1.9	0.8	1.4
		17.0	2.1	0.9	1.8	0.8	1.1
		27.0	1.9	0.9	2.0	1.0	0.9
	13.0	7.0	3.2	2.0	2.7	2.2	3.0
		12.0	2.2	0.9	1.1	0.8	1.0
		21.0	3.2	1.5	1.6	1.4	1.9
	17.0	7.0	2.0	1.9	4.0	2.0	3.3
		12.0	2.2	1.2	1.4	1.4	2.1
		18.0	2.4	1.6	2.1	2.2	3.0

(CONTINUED)

TABLE 14 (CONCLUDED)

Test Wave Direction	Test Wave Period sec	Test Wave Height ft	Wave Height, ft Gage 11	Gage 12	Gage 13	Gage 14	Gage 15
SW	5.0	7.0	2.7	1.3	0.1	<0.1	0.3
		12.0	2.2	1.2	0.1	0.2	0.3
	7.0	7.0	1.7	0.9	<0.1	0.2	0.2
		12.0	4.7	1.2	0.3	0.3	0.5
		20.0	3.3	1.8	0.2	0.3	0.3
	9.0	7.0	1.7	1.1	0.2	0.1	0.2
		13.0	1.9	1.3	0.4	0.2	0.3
		21.0	1.9	1.6	0.4	0.2	0.3
		27.0	3.2	1.8	0.3	0.2	0.3
	11.0	7.0	2.5	1.3	0.2	0.1	0.2
		13.0	2.6	2.0	0.6	0.2	0.2
		21.0	2.3	1.3	0.3	0.2	0.2
		29.0	3.3	2.1	0.5	0.2	0.4
	13.0	7.0	3.6	1.8	0.4	0.2	0.4
		13.0	3.0	1.9	0.4	0.2	0.3
		21.0	3.4	1.1	0.4	0.3	0.3
		27.0	3.3	1.7	0.5	0.3	0.4
	15.0	7.0	3.2	1.1	0.2	0.1	0.4
		12.0	2.6	2.2	0.6	0.5	0.4
		17.0	2.5	1.4	0.5	0.5	0.4
		25.0	2.5	1.6	0.4	0.3	0.4
	17.0	7.0	3.3	0.9	0.3	0.3	0.3
		12.0	4.7	2.1	0.5	0.5	0.5
		18.0	4.2	2.1	0.7	0.5	0.5
SSW	5.0	7.0	2.4	0.7	<0.1	<0.1	0.1
		12.0	1.8	0.8	<0.1	<0.1	0.1
	9.0	7.0	2.6	1.2	0.2	0.1	0.2
		12.0	2.3	0.5	<0.1	0.1	0.2
		17.0	1.5	0.9	0.2	0.1	0.2
		27.0	2.1	1.1	0.1	0.1	0.2
	13.0	7.0	3.5	1.5	0.2	<0.1	0.3
		12.0	2.5	1.1	0.2	0.1	0.2
		21.0	3.7	1.7	0.3	0.2	0.3
	17.0	7.0	5.4	1.9	0.4	0.4	0.4
		12.0	2.5	1.1	0.2	0.2	0.2
		18.0	4.1	1.5	0.2	0.2	0.2

TABLE 15

WAVE HEIGHTS FOR BASE TEST 2 TIDAL FLOW CONDITIONS

Test Wave Direction	Test Wave Period, sec	Test Wave Height, ft	Wave Height, ft: Gage 1	Gage 2	Gage 3	Gage 4	Gage 5
			SWL = +1.5 FT(MAXIMUM EBB)				
SW	5.0	7.0	8.7	9.9	6.9	2.0	0.7
		12.0	9.2	8.0	6.0	2.7	1.1
	7.0	7.0	5.9	6.9	12.8	2.9	1.5
		12.0	12.9	14.4	7.5	3.0	1.6
		20.0	18.9	12.4	8.7	3.7	1.4
	9.0	7.0	8.1	7.8	9.5	2.8	1.6
		13.0	16.3	17.4	8.2	1.4	0.9
		21.0	19.5	12.1	8.5	2.4	1.4
		27.0	13.3	15.0	8.7	3.9	2.2
	11.0	7.0	8.9	11.0	10.1	3.8	1.3
		13.0	20.0	16.2	8.1	2.8	1.2
		21.0	19.1	14.5	8.1	2.4	1.5
		29.0	18.3	14.8	10.3	3.5	1.9
	13.0	7.0	8.2	7.4	11.0	3.9	1.6
		13.0	20.4	15.1	8.5	2.0	1.8
		21.0	16.2	17.7	10.1	3.1	1.7
		27.0	16.2	16.5	10.5	2.7	2.1
	15.0	7.0	7.9	9.6	9.5	4.2	2.0
		12.0	19.9	15.9	8.5	1.7	1.7
		17.0	19.5	14.8	9.3	2.9	1.8
		25.0	24.7	14.5	10.7	2.4	1.7
	17.0	7.0	9.1	8.2	10.5	4.0	1.5
		12.0	20.3	14.1	9.1	2.2	2.0
		18.0	19.7	14.1	10.5	3.0	2.4
			SWL = +4.3 FT(MAXIMUM FLOOD)				
	5.0	7.0	9.6	9.2	6.7	2.1	1.7
		12.0	9.2	9.9	8.1	2.4	1.3
	7.0	7.0	5.6	7.1	7.8	1.9	1.7
		12.0	13.6	14.1	9.2	6.0	2.1
		20.0	18.6	9.9	7.5	1.9	1.5
	9.0	7.0	8.6	7.8	8.2	1.6	2.0
		13.0	15.0	15.6	7.9	1.2	1.9
		21.0	17.0	16.4	10.4	3.0	2.1
		27.0	22.5	14.5	11.4	3.1	2.9
	11.0	7.0	7.0	8.9	12.8	2.5	3.0
		13.0	17.5	17.3	10.3	1.7	1.8
		21.0	17.8	16.5	11.3	4.2	2.5
		29.0	21.3	17.3	11.5	3.5	1.7
	13.0	7.0	7.7	9.0	13.2	3.7	1.7
		13.0	14.4	18.9	9.0	2.2	1.6
		21.0	14.9	17.6	12.1	2.9	2.2
		27.0	20.3	17.2	13.1	3.7	2.3
	15.0	7.0	6.6	9.8	12.3	3.1	2.2
		12.0	12.8	15.9	10.3	2.2	2.3
		17.0	28.8	15.8	10.1	1.6	2.3
		25.0	18.2	16.0	12.8	3.5	1.6
	17.0	7.0	7.2	10.1	10.6	3.3	1.8
		12.0	14.2	16.4	12.3	3.8	2.8
		18.0	26.6	15.1	12.5	4.3	2.2

(CONTINUED)

(SHEET 1 OF 3)

TABLE 15 (CONTINUED)

TEST WAVE DIRECTION	PERIOD SEC	HEIGHT FT	WAVE HEIGHT, FT GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10
			SWL = +1.5 FT(MAXIMUM EBB)				
SW	5.0	7.0	0.4	0.4	0.6	0.5	0.2
		12.0	0.9	0.7	1.2	0.8	0.5
	7.0	7.0	1.6	1.0	1.7	1.0	0.6
		12.0	0.9	0.9	2.3	0.9	0.6
		20.0	0.9	0.8	2.5	1.3	1.1
	9.0	7.0	1.2	0.7	2.8	0.8	0.4
		13.0	0.8	0.4	0.9	0.6	0.4
		21.0	1.0	0.8	1.3	0.7	0.6
		27.0	1.5	0.8	1.7	0.8	0.6
	11.0	7.0	1.1	0.7	2.2	0.8	0.6
		13.0	1.2	0.6	0.8	0.5	0.6
		21.0	1.3	0.7	1.3	0.8	0.6
		29.0	1.7	1.0	1.8	1.4	1.3
	13.0	7.0	1.3	0.7	1.6	0.6	0.9
		13.0	1.5	0.7	1.1	0.6	0.6
		21.0	1.5	0.7	1.8	1.0	1.0
		27.0	2.1	0.8	1.5	1.3	1.4
	15.0	7.0	1.8	0.8	1.1	0.9	1.7
		12.0	1.5	0.6	0.7	0.6	0.9
		17.0	1.6	0.7	1.0	0.6	0.7
		25.0	1.7	0.9	1.3	1.0	1.3
	17.0	7.0	1.5	0.7	1.4	0.9	1.4
		12.0	1.9	0.8	1.1	0.8	1.2
		18.0	1.7	0.7	1.3	0.8	1.0
			SWL = +4.3 FT(MAXIMUM FLOOD)				
	5.0	7.0	0.8	0.9	1.1	1.3	0.9
		12.0	1.0	0.7	1.1	0.9	0.7
	7.0	7.0	0.7	0.4	0.8	0.6	0.4
		12.0	1.5	1.2	2.6	1.9	2.0
		20.0	1.2	0.8	2.4	1.8	1.3
	9.0	7.0	1.6	0.7	1.5	1.3	0.8
		13.0	0.9	0.6	1.0	0.9	1.3
		21.0	1.3	0.8	2.9	1.5	1.3
		27.0	2.1	0.9	2.1	1.5	1.2
	11.0	7.0	2.7	1.2	0.8	0.8	1.1
		13.0	1.2	0.5	0.7	0.6	0.6
		21.0	2.2	1.0	2.5	1.5	1.4
		29.0	2.0	0.8	1.5	0.9	1.3
	13.0	7.0	1.1	0.6	1.0	0.8	1.2
		13.0	0.9	0.5	0.6	0.5	0.7
		21.0	2.1	0.8	1.2	0.9	1.3
		27.0	2.1	1.0	1.7	1.4	1.5
	15.0	7.0	1.7	1.0	0.9	1.0	1.4
		12.0	1.2	0.5	0.8	0.8	1.1
		17.0	1.8	0.7	1.1	0.9	1.5
		25.0	1.6	1.1	2.0	1.7	2.2
	17.0	7.0	1.6	1.0	0.9	1.0	1.5
		12.0	1.8	1.1	1.7	1.6	2.4
		18.0	1.3	0.8	1.5	1.1	1.5

(CONTINUED)

TABLE 15 (CONCLUDED)

Test Wave Direction	Test Wave Period Sec	Test Wave Height Ft	Wave Height, Ft Gage 11	Wave Height, Ft Gage 12	Wave Height, Ft Gage 13	Wave Height, Ft Gage 14	Wave Height, Ft Gage 15
			SWL = +1.5 FT(MAXIMUM EBB)				
SW	5.0	7.0	1.0	0.2	<0.1	<0.1	<0.1
		12.0	1.4	0.4	<0.1	<0.1	<0.1
	7.0	7.0	1.8	0.4	<0.1	<0.1	<0.1
		12.0	1.7	0.5	<0.1	<0.1	<0.1
		20.0	1.9	0.6	<0.1	<0.1	<0.1
	9.0	7.0	2.7	0.3	<0.1	<0.1	<0.1
		13.0	0.9	0.3	<0.1	<0.1	<0.1
		21.0	1.6	0.4	<0.1	<0.1	<0.1
		27.0	2.2	0.6	<0.1	0.1	<0.1
	11.0	7.0	2.4	0.9	<0.1	<0.1	<0.1
		13.0	1.6	0.4	<0.1	<0.1	<0.1
		21.0	1.6	0.6	<0.1	<0.1	<0.1
		29.0	2.6	0.7	0.1	0.1	<0.1
	13.0	7.0	2.4	0.6	<0.1	<0.1	<0.1
		13.0	2.4	0.5	<0.1	<0.1	<0.1
		21.0	2.5	1.2	0.1	0.1	0.2
		27.0	2.6	0.8	0.2	0.1	0.1
	15.0	7.0	3.6	1.0	0.1	<0.1	<0.1
		12.0	2.0	0.6	0.1	<0.1	0.1
		17.0	1.9	0.6	0.1	0.1	0.2
		25.0	2.9	0.8	0.2	0.1	0.1
	17.0	7.0	2.3	0.9	0.1	<0.1	0.2
		12.0	2.4	0.5	<0.1	<0.1	<0.1
		18.0	2.5	0.6	0.1	0.1	0.1
			SWL = +4.3 FT(MAXIMUM FLOOD)				
	5.0	7.0	1.8	0.7	<0.1	<0.1	0.1
		12.0	1.1	0.7	<0.1	<0.1	0.1
	7.0	7.0	0.9	0.5	<0.1	<0.1	0.1
		12.0	3.1	1.4	0.1	0.2	0.2
		20.0	1.4	0.5	<0.1	0.1	0.1
	9.0	7.0	1.4	0.8	0.1	0.1	0.1
		13.0	1.8	0.5	<0.1	<0.1	0.1
		21.0	1.9	1.5	0.2	0.1	0.2
		27.0	1.3	1.0	0.1	0.1	0.2
	11.0	7.0	2.1	1.2	0.1	<0.1	0.1
		13.0	1.4	0.7	<0.1	<0.1	<0.1
		21.0	1.7	1.8	0.2	0.2	0.2
		29.0	1.8	1.4	0.2	0.2	0.3
	13.0	7.0	2.1	0.7	<0.1	<0.1	<0.1
		13.0	1.2	0.6	0.1	<0.1	0.2
		21.0	1.9	1.3	0.2	0.2	0.2
		27.0	2.3	2.2	0.3	0.2	0.5
	15.0	7.0	2.0	0.7	0.2	<0.1	0.2
		12.0	1.3	0.5	0.2	0.1	0.1
		17.0	1.9	0.8	0.2	0.1	0.2
		25.0	2.1	1.3	0.3	0.2	0.3
	17.0	7.0	2.3	0.9	0.2	0.2	0.2
		12.0	3.6	1.3	0.3	0.2	0.3
		18.0	2.4	1.2	0.2	0.2	0.2

(SHEET 3 OF 3)

Table 16

Water-Surface Elevations, Base Test 2

Discharge cfs	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Water-Surface Elevation* at Indicated Station, ft								
				swl = 0.0 ft					
50,000	0.0	0.0	0.1	0.1	0.1	0.2	0.4	0.4	0.5
100,000	0.1	0.6	0.6	1.0	1.0	1.3	1.7	1.9	2.4
150,000	0.1	0.7	1.4	1.9	2.2	2.3	3.0	3.3	4.2
200,000	0.2	1.3	2.0	3.0	3.5	3.5	4.3	4.6	5.9
250,000	0.8	2.0	3.2	4.3	4.9	5.0	5.6	6.0	7.5
300,000	1.4	3.1	4.6	5.8	6.4	6.5	7.2	7.7	9.2
350,000	2.0	4.2	6.0	7.3	8.1	8.2	8.5	9.0	10.8
				swl = +6.7 ft					
50,000	6.7	6.7	6.7	6.7	6.8	6.8	6.9	6.9	6.9
100,000	6.7	6.8	6.8	6.9	6.9	7.0	7.1	7.1	7.2
150,000	6.8	6.9	7.1	7.3	7.3	7.4	7.4	7.6	8.0
200,000	6.8	7.0	7.4	7.8	7.9	8.1	8.1	8.3	8.9
250,000	6.8	7.2	7.8	8.3	8.5	8.7	8.8	9.1	9.9
300,000	7.0	7.5	8.2	9.0	9.4	9.5	9.5	9.9	10.9
350,000	7.3	7.9	8.9	9.7	10.3	10.4	10.5	10.8	12.1

*Elevation referenced to mllw.

Table 17

River Current Velocities Obtained for Base Test 2

Discharge cfs	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Velocity at Indicated Station, fps								
				swl = 0.0 ft					
50,000	2.7	2.8	2.5	2.2	1.3	1.4	3.4	3.5	2.5
100,000	6.1	6.0	5.6	4.6	2.6	3.0	5.1	6.1	4.2
150,000	9.1	8.8	7.7	5.6	3.8	4.5	7.0	7.5	5.8
200,000	11.1	10.7	10.0	8.8	4.7	6.0	8.8	9.4	6.4
250,000	13.6	12.5	10.7	9.1	6.3	6.8	10.7	10.3	7.1
300,000	15.8	14.3	12.5	10.0	7.3	8.6	12.0	11.5	8.1
350,000	16.7	15.8	13.6	11.1	8.6	9.4	13.6	13.0	8.8
				swl = +6.7 ft					
50,000	2.0	2.0	1.8	1.4	1.1	1.4	1.6	1.9	1.3
100,000	4.3	4.2	3.4	3.2	2.5	3.0	3.3	4.1	3.1
150,000	6.7	6.3	5.5	4.5	3.5	4.1	4.9	5.2	4.3
200,000	8.6	7.9	6.8	6.0	5.3	5.1	6.7	7.1	5.9
250,000	10.3	10.0	9.1	7.5	5.7	6.4	8.1	8.6	6.7
300,000	10.7	10.3	9.4	8.8	5.9	6.8	8.8	9.4	7.1
350,000	14.3	13.0	10.7	9.7	8.3	9.4	10.3	11.1	7.9

Table 18

Water-Surface Elevations, Plan 2

Discharge cfs	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Water-Surface Elevation* at Indicated Station, ft								
				swl = 0.0 ft					
50,000	0.1	0.1	0.6	0.7	0.7	0.8	0.9	1.1	1.1
100,000	0.1	0.2	1.8	2.2	2.3	2.5	2.7	2.9	3.2
150,000	0.1	0.4	3.8	4.6	4.9	4.9	5.1	5.4	5.7
200,000	0.4	1.8	6.3	7.3	7.5	7.7	7.7	7.9	8.4
250,000	2.2	3.2	9.2	10.3	10.7	10.7	10.7	10.7	11.4
300,000	2.6	5.4	11.7	13.0	13.3	13.4	13.4	13.4	14.0
350,000	3.2	8.0	13.8	15.3	15.3	15.4	15.4	15.5	16.3
				swl = +6.7 ft					
50,000	7.0	7.0	7.2	7.3	7.3	7.4	7.4	7.4	7.4
100,000	7.0	7.0	8.0	8.0	8.2	8.2	8.2	8.3	8.3
150,000	7.0	7.0	9.0	9.2	9.4	9.4	9.4	9.6	9.8
200,000	7.2	7.3	10.0	10.8	10.8	10.9	10.9	11.0	11.4
250,000	7.5	7.9	11.4	12.3	12.6	12.7	12.7	12.7	13.2
300,000	7.5	9.0	13.0	14.1	14.4	14.5	14.5	14.7	15.0
350,000	7.6	10.2	15.0	15.9	16.0	16.2	16.2	16.4	16.9

* Elevation referenced to mllw.

Table 19

Water-Surface Elevations, Plan 2

Discharge cfs	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Water-Surface Elevation* at Indicated Station, ft								
				swl = 0.0 ft					
50,000	0.1	0.2	0.5	0.5	0.6	0.6	0.8	0.8	0.8
100,000	0.2	0.6	1.7	1.8	1.9	1.9	2.2	2.2	2.6
150,000	0.3	1.1	2.8	3.4	3.8	3.9	4.1	4.1	4.8
200,000	0.5	1.8	4.5	5.5	5.9	6.1	6.1	6.2	7.0
250,000	1.0	3.0	7.1	7.8	8.3	8.4	8.4	8.5	9.4
300,000	1.7	4.9	9.1	10.4	10.7	10.8	10.9	10.9	11.6
350,000	1.9	6.2	10.6	11.9	12.3	12.5	12.5	12.5	13.4
				swl = +6.7 ft					
50,000	6.7	6.7	6.8	6.9	6.9	6.9	6.9	7.0	7.0
100,000	6.7	6.8	7.2	7.4	7.5	7.5	7.5	7.7	7.9
150,000	6.7	6.8	7.9	8.2	8.4	8.4	8.4	8.5	8.9
200,000	6.7	7.0	8.7	9.2	9.4	9.5	9.5	9.8	10.1
250,000	6.7	7.2	9.8	10.6	10.9	11.0	11.0	11.2	11.7
300,000	6.8	7.9	11.0	12.0	12.3	12.5	12.5	12.7	13.4
350,000	6.8	8.4	12.7	13.8	14.2	14.2	14.2	14.4	15.2

* Elevation referenced to mllw.

Table 20

Water-Surface Elevations, Plan 3

Discharge cfs	Water-Surface Elevation* at Indicated Station, ft Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
				swl = 0.0 ft					
50,000	0.1	0.2	0.4	0.5	0.6	0.6	0.7	0.7	0.8
100,000	0.3	0.5	1.1	1.5	1.9	1.9	2.1	2.2	2.6
150,000	0.3	0.9	2.9	3.4	3.9	3.9	4.1	4.2	4.9
200,000	0.4	1.7	4.4	5.6	6.0	6.2	6.2	6.2	6.9
250,000	0.7	2.2	6.5	7.4	8.0	8.0	8.2	8.4	9.2
300,000	1.3	4.2	8.7	9.7	10.2	10.4	10.4	10.6	11.5
350,000	1.7	5.7	10.3	11.5	11.9	12.1	12.1	12.2	13.0
				swl = +6.7 ft					
50,000	6.7	6.7	6.8	6.8	6.8	6.8	6.9	7.0	7.0
100,000	6.7	6.8	7.1	7.4	7.4	7.4	7.5	7.6	7.8
150,000	6.7	6.8	7.6	7.9	8.1	8.1	8.2	8.2	8.6
200,000	6.7	6.9	8.3	8.8	9.0	9.1	9.2	9.3	9.8
250,000	6.7	7.0	9.3	9.9	10.4	10.4	10.4	10.6	11.2
300,000	6.7	7.4	10.5	11.3	11.8	11.8	11.8	12.0	12.7
350,000	6.8	7.8	11.8	12.8	13.4	13.3	13.4	13.6	14.4

* Elevation referenced to mllw.

Table 21

Water-Surface Elevations, Plan 3A

Discharge cfs	Water-Surface Elevation* at Indicated Station, ft Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
					swl = 0.0 ft				
50,000	0.2	0.3	0.5	0.5	0.6	0.7	0.7	0.7	0.9
100,000	0.3	0.6	1.6	1.8	1.9	1.9	2.2	2.2	2.7
150,000	0.4	1.2	3.0	3.5	3.9	4.0	4.1	4.2	4.8
200,000	0.6	1.6	4.3	5.0	5.6	5.7	5.8	6.0	6.7
250,000	0.8	2.5	6.3	7.3	7.8	7.8	7.9	8.1	9.0
300,000	1.1	3.6	8.2	9.3	9.9	9.9	9.9	10.1	11.0
350,000	1.4	5.0	10.0	11.2	11.9	11.9	11.9	12.0	13.1
					swl = +6.7 ft				
50,000	6.7	6.7	6.7	6.8	6.8	6.8	6.8	7.0	7.0
100,000	6.7	6.8	7.2	7.4	7.5	7.5	7.5	7.5	7.6
150,000	6.7	6.9	7.7	8.0	8.2	8.2	8.3	8.3	8.5
200,000	6.7	7.0	8.3	8.8	9.1	9.1	9.2	9.2	9.7
250,000	6.7	7.0	9.4	10.0	10.4	10.4	10.4	10.4	11.0
300,000	6.8	7.3	10.5	11.4	11.8	11.9	11.7	11.9	12.6
350,000	6.8	8.0	11.6	12.6	13.1	13.1	13.2	13.3	14.1

* Elevation referenced to mllw.

Table 22

Water-Surface Elevations, Plan 3B

Discharge cfs	Water-Surface Elevation* at Indicated Station, ft								
	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
				swl = 0.0 ft					
50,000	0.0	0.1	0.5	0.7	0.8	0.8	0.9	1.0	1.1
100,000	0.1	0.2	1.9	2.3	2.4	2.5	2.7	2.8	3.2
150,000	0.2	0.4	3.6	4.5	4.8	4.8	4.9	5.3	5.7
200,000	0.4	0.9	6.0	7.0	7.5	7.5	7.5	7.6	8.4
250,000	0.7	1.2	8.4	9.6	10.0	10.0	10.0	10.1	10.9
300,000	1.4	1.9	10.5	11.6	12.2	12.2	12.2	12.3	13.2
350,000	1.7	4.4	12.6	13.5	14.0	14.0	14.0	14.1	15.1
				swl = +6.7 ft					
50,000	6.8	6.8	7.1	7.2	7.2	7.2	7.2	7.3	7.3
100,000	6.9	6.9	7.6	7.9	8.0	8.0	8.0	8.0	8.0
150,000	6.9	6.9	8.3	8.9	9.1	9.1	9.1	9.1	9.3
200,000	7.0	7.1	9.5	10.1	10.4	10.4	10.4	10.4	10.8
250,000	7.0	7.1	11.0	11.5	11.9	11.9	11.9	12.0	12.5
300,000	7.0	7.8	12.4	13.0	13.5	13.5	13.5	13.5	14.1
350,000	7.2	8.0	13.6	14.6	14.9	14.9	14.9	14.9	15.7

* Elevation referenced to mllw.

Table 23

Water-Surface Elevations, Plan 7J

Discharge cfs	Water-Surface Elevation* at Indicated Station, ft									
	Sta 1000	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
					swl = 0.0 ft					
50,000	0.0	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7
100,000	0.0	0.1	0.6	0.8	1.1	1.3	1.4	1.7	2.0	2.7
150,000	0.0	0.6	1.3	1.7	2.1	2.6	2.7	3.0	3.4	4.4
200,000	0.0	1.1	2.3	2.9	3.5	4.1	4.1	4.5	5.0	6.2
250,000	0.0	2.8	3.4	4.2	5.0	5.6	5.7	6.0	6.5	7.9
300,000	0.0	3.0	4.8	5.7	6.6	7.3	7.5	7.7	8.0	9.7
350,000	0.0	4.4	6.4	7.4	8.4	9.1	9.2	9.3	9.7	11.5
					swl = +6.7 ft					
50,000	6.7	6.7	6.7	6.7	6.7	6.8	6.8	6.8	6.8	6.8
100,000	6.7	6.7	6.8	6.9	7.1	7.1	7.1	7.1	7.2	7.4
150,000	6.7	6.7	7.0	7.1	7.5	7.5	7.5	7.5	7.7	8.0
200,000	6.7	6.8	7.3	7.6	8.0	8.1	8.2	8.2	8.4	9.0
250,000	6.7	6.8	7.7	8.1	8.6	9.0	9.0	9.0	9.3	10.1
300,000	6.7	7.3	8.3	8.8	9.3	9.9	10.0	10.0	10.2	11.3
350,000	6.7	7.7	8.9	9.5	10.3	10.9	10.9	11.0	11.3	12.5

* Elevation referenced to mllw.

Table 24

Water-Surface Elevations, Plan 8D

Discharge cfs	Sta 1000	Sta 2000	Sta 3000	Sta 4000	Sta 4800	Sta 5600	Sta 6400	Sta 7100	Sta 7900	Sta 8800
	Water-Surface Elevation* at Indicated Station, ft									
					swl = 0.0 ft					
50,000	0.0	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.8
100,000	0.0	0.4	0.5	0.8	1.0	1.2	1.2	1.6	1.9	2.6
150,000	0.0	0.7	1.1	1.5	2.0	2.4	2.5	3.0	3.3	4.4
200,000	0.0	1.1	1.8	2.6	3.2	3.9	3.9	4.6	4.8	6.2
250,000	0.0	1.8	2.6	3.6	4.5	5.3	5.3	5.9	6.2	7.8
300,000	0.0	2.4	3.8	4.6	5.8	6.7	6.8	7.1	7.6	9.3
350,000	0.0	3.4	4.8	6.0	7.3	8.2	8.2	8.6	9.0	10.9
					swl = +6.7 ft					
50,000	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.9
100,000	6.7	6.9	6.9	6.9	7.0	7.0	7.1	7.2	7.2	7.3
150,000	6.7	7.0	7.1	7.1	7.3	7.5	7.6	7.6	7.6	8.1
200,000	6.7	7.1	7.3	7.4	7.7	8.0	8.1	8.2	8.2	8.9
250,000	6.7	7.2	7.5	7.7	8.2	8.6	8.8	8.9	9.0	9.9
300,000	6.7	7.3	7.7	8.2	8.9	9.4	9.4	9.7	9.9	10.9
350,000	6.7	7.6	8.3	8.9	9.7	10.2	10.4	10.6	10.8	12.2

* Elevation referenced to mllw.

TABLE 25

WAVE HEIGHTS FOR PLAN 11B FOR TEST WAVES

FROM SOUTHWEST AND SOUTH-SOUTHWEST, SWL = +6.7 FT

Test Wave			Wave Height, ft									
Direction	Period sec	Height ft	Gage 13	Gage 14	Gage 15	Gage 16	Gage 17	Gage 18	Gage 19	Gage 20	Gage 21	Gage 22
SSW	5.0	7.0	0.3	0.3	0.1	<0.1	0.1	1.0	1.6	2.1	5.0	8.3
		12.0	0.2	0.2	0.1	<0.1	0.2	0.8	1.5	2.4	5.4	8.6
	9.0	7.0	0.2	0.1	0.1	<0.1	0.2	0.4	0.7	1.7	4.2	5.0
		12.0	0.3	0.2	0.1	0.1	0.3	0.5	0.5	2.8	5.4	12.3
		17.0	0.5	0.2	0.3	0.2	0.3	1.4	1.9	4.6	9.4	19.6
		27.0	0.4	0.2	0.2	0.2	0.3	1.2	1.6	3.9	7.8	15.5
	13.0	7.0	0.3	0.3	0.2	0.3	0.4	0.8	1.2	2.0	5.0	8.9
		12.0	0.7	0.5	0.5	0.4	0.6	1.3	1.6	3.8	11.0	12.4
		21.0	0.9	0.7	0.5	0.5	0.6	1.6	2.1	4.4	9.9	16.7
	17.0	7.0	0.3	0.3	0.1	<0.1	0.2	0.8	1.0	2.2	6.4	9.2
		12.0	0.5	0.4	0.3	0.2	0.3	1.3	2.1	4.1	8.0	17.9
		18.0	0.7	0.5	0.4	0.2	0.4	1.7	2.3	5.4	9.5	19.5
SW	5.0	7.0	0.2	0.2	0.1	<0.1	0.1	0.8	1.2	1.9	2.4	7.0
		12.0	0.2	0.2	<0.1	<0.1	0.1	0.5	0.9	1.4	2.4	6.4
	9.0	7.0	0.2	<0.1	0.1	<0.1	0.1	0.4	0.5	1.9	2.8	5.2
		13.0	0.3	0.2	0.2	0.1	0.2	0.7	0.7	2.5	6.7	14.6
		21.0	0.4	0.2	0.3	0.1	0.2	0.9	1.2	3.6	6.2	14.9
		27.0	0.5	0.3	0.3	0.2	0.4	1.2	1.5	3.6	6.1	12.2
	13.0	7.0	0.6	0.6	0.4	0.4	0.5	1.1	1.5	2.5	4.3	9.3
		13.0	0.9	0.7	0.6	0.5	0.6	1.3	1.8	3.1	6.9	12.2
		21.0	0.8	0.8	0.6	0.3	0.7	1.3	1.9	3.9	8.1	12.9
		27.0	0.8	0.7	0.5	0.4	0.5	1.1	2.3	4.4	8.8	14.5
	17.0	7.0	0.6	0.5	0.3	0.2	0.3	1.4	1.9	2.6	6.2	10.5
		12.0	0.8	0.6	0.4	0.2	0.4	1.8	3.0	5.5	11.7	17.1
		18.0	0.5	0.6	0.5	0.3	0.4	1.2	2.0	3.4	11.5	16.7

Photo 1. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 27-ft waves from NNW for maximum ebb; swl = +1.5 ft

Photo 2. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from NNW for maximum ebb; swl = +1.5 ft

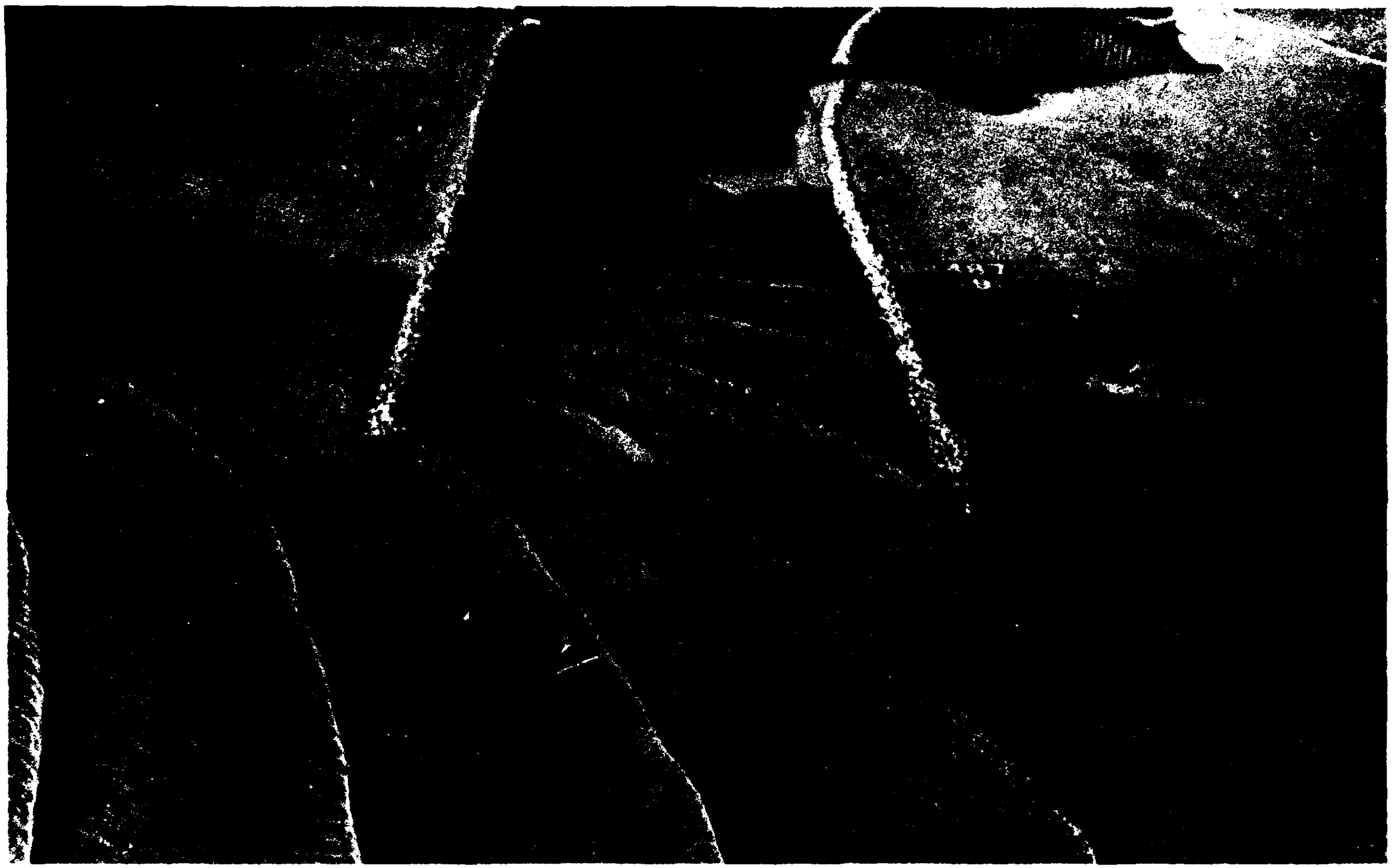


Photo 3. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from NNW for maximum ebb; swl = +1.5 ft

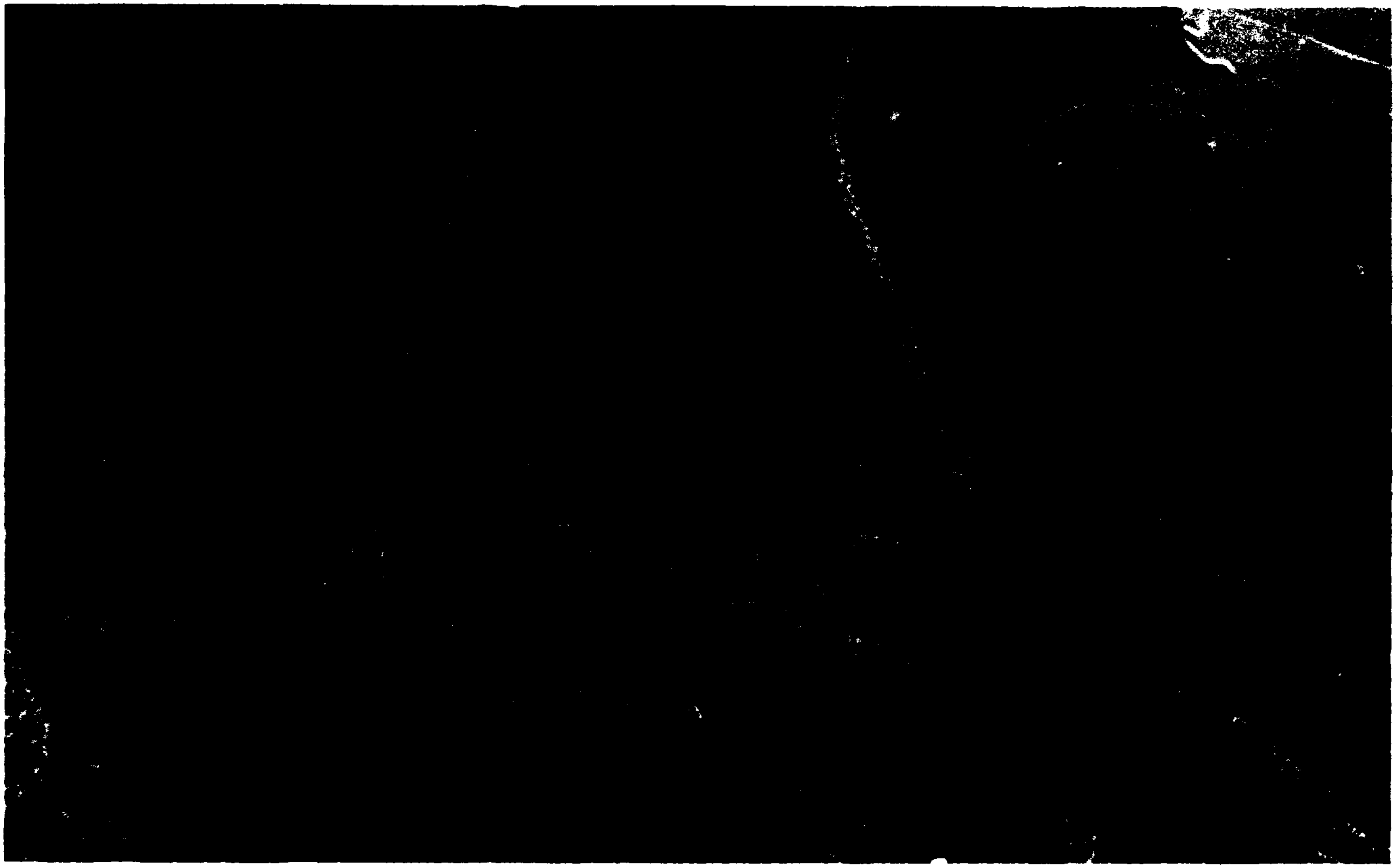


Photo 4. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 27-ft waves from NNW for maximum flood; swl = +4.3 ft

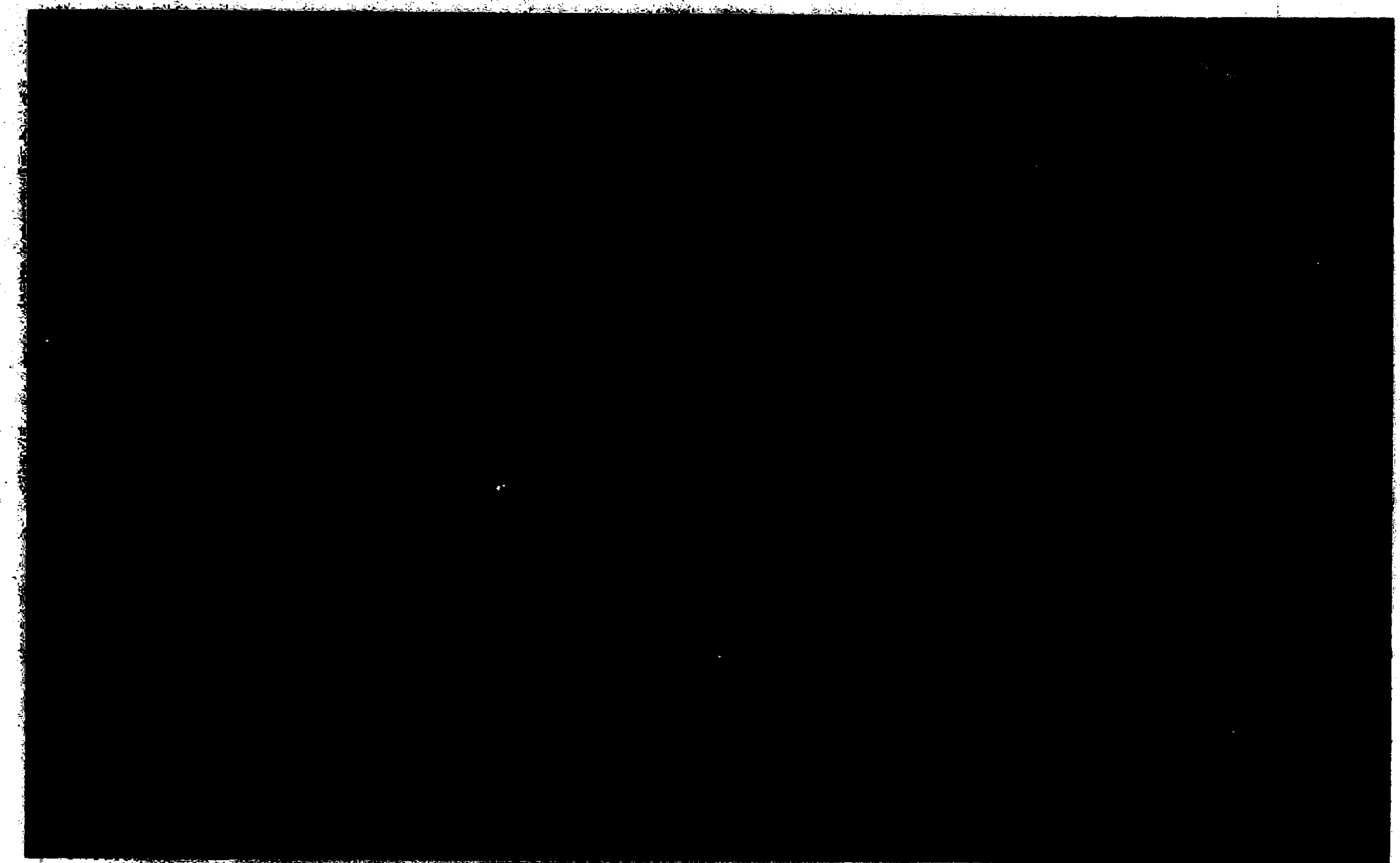


Photo 5. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from NNW for maximum flood; swl = +4.3 ft

Photo 6. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from NNW for maximum flood; swl = +4.3 ft

Photo 7. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from NNW; swl = +6.7 ft

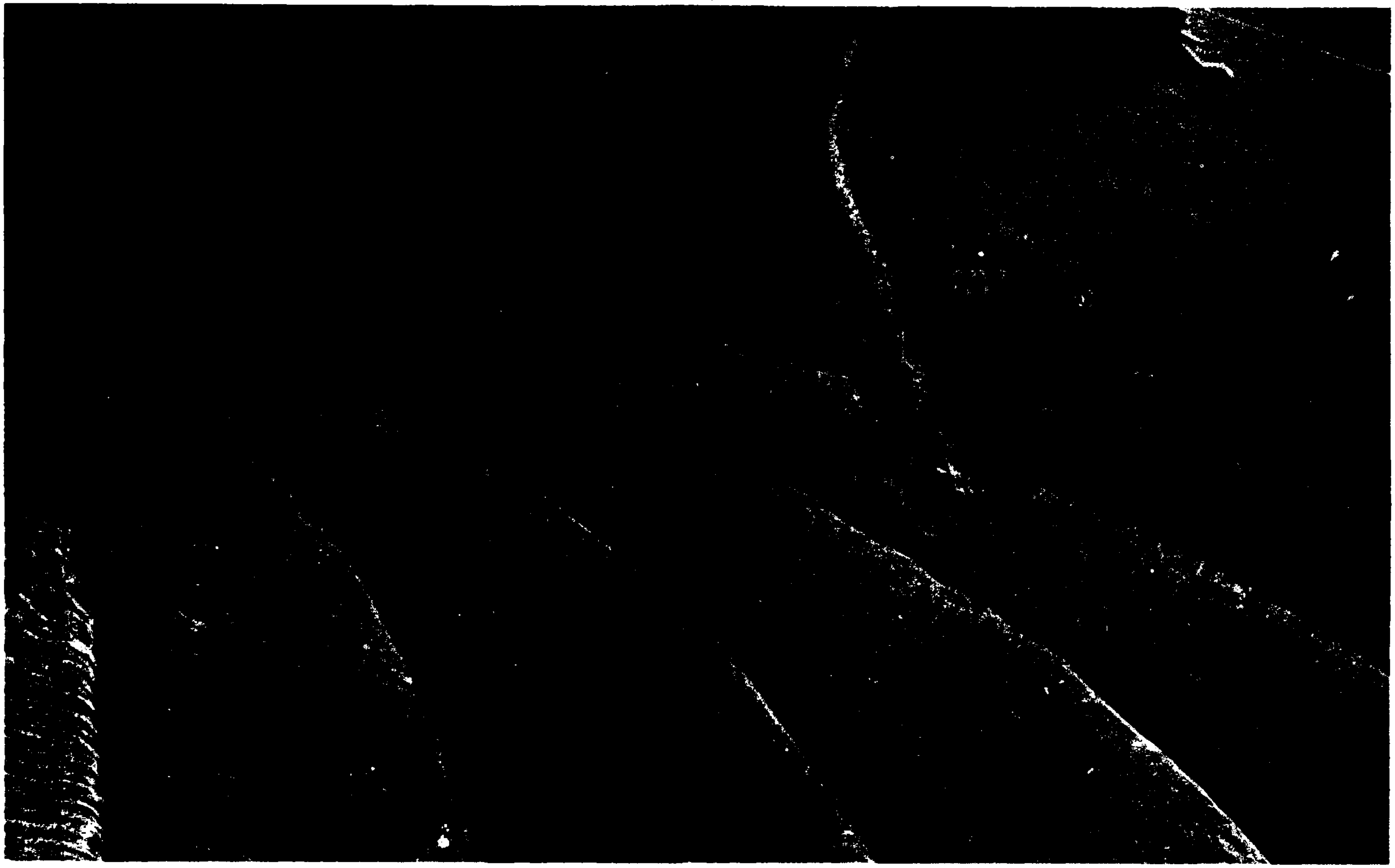


Photo 8. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from NNW; swl = +6.7 ft

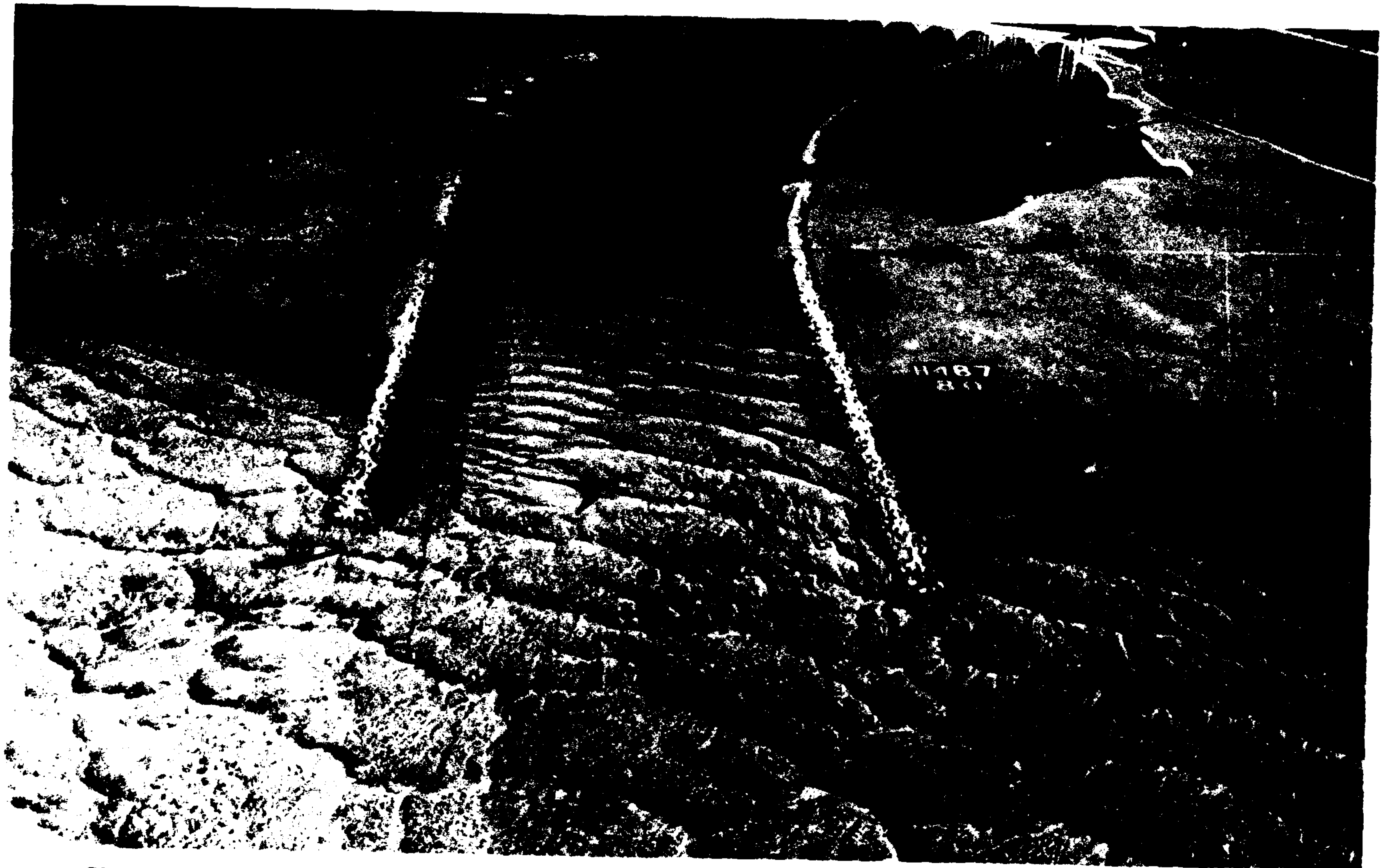


Photo 9. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 23-ft waves from west for maximum ebb; swl = +1.5 ft

Photo 10. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from west for maximum ebb; swl = +1.5 ft

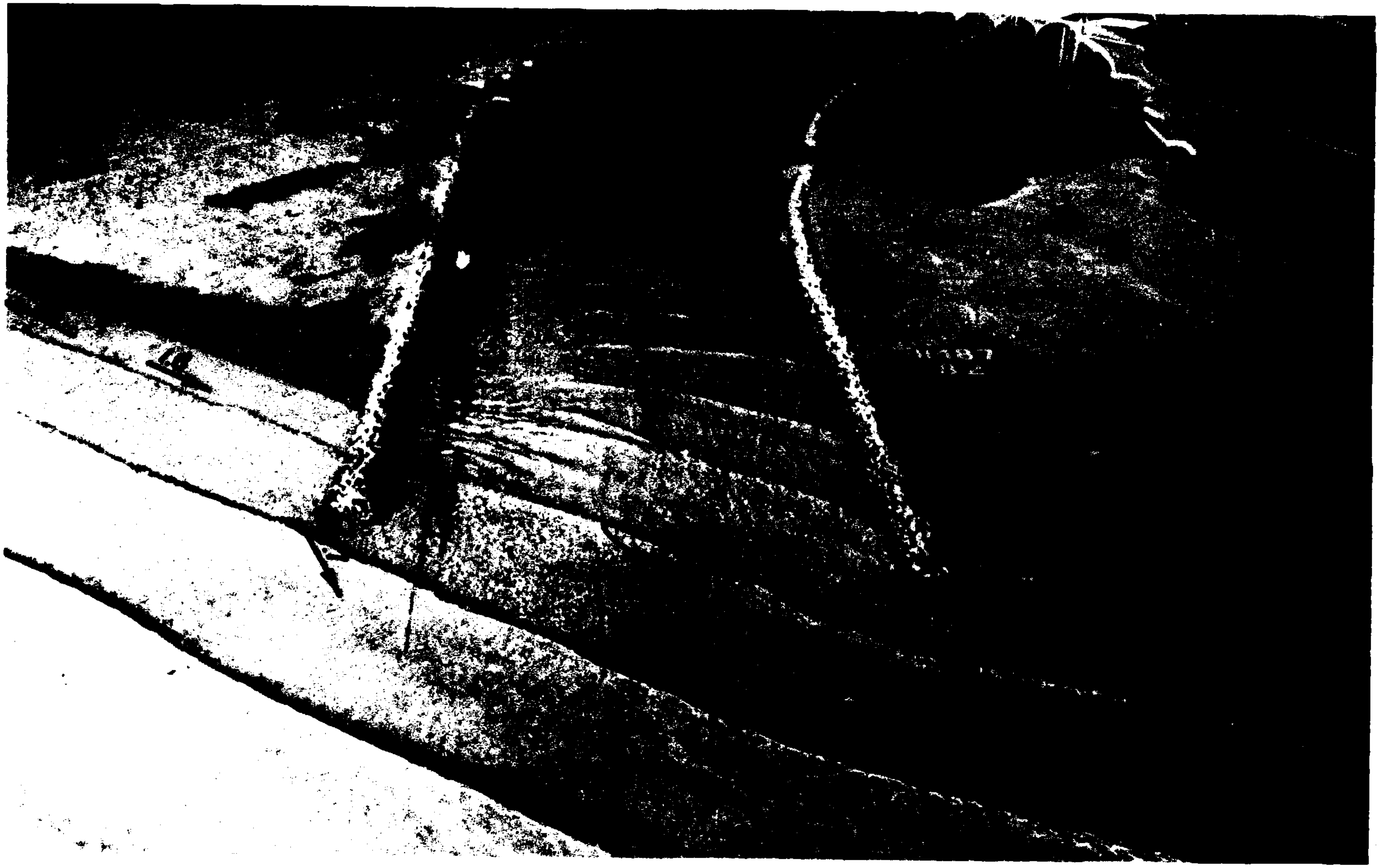


Photo 11. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from west for maximum ebb; swl = +1.5 ft

Photo 12. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 23-ft waves from west for maximum flood; swl = +4.3 ft

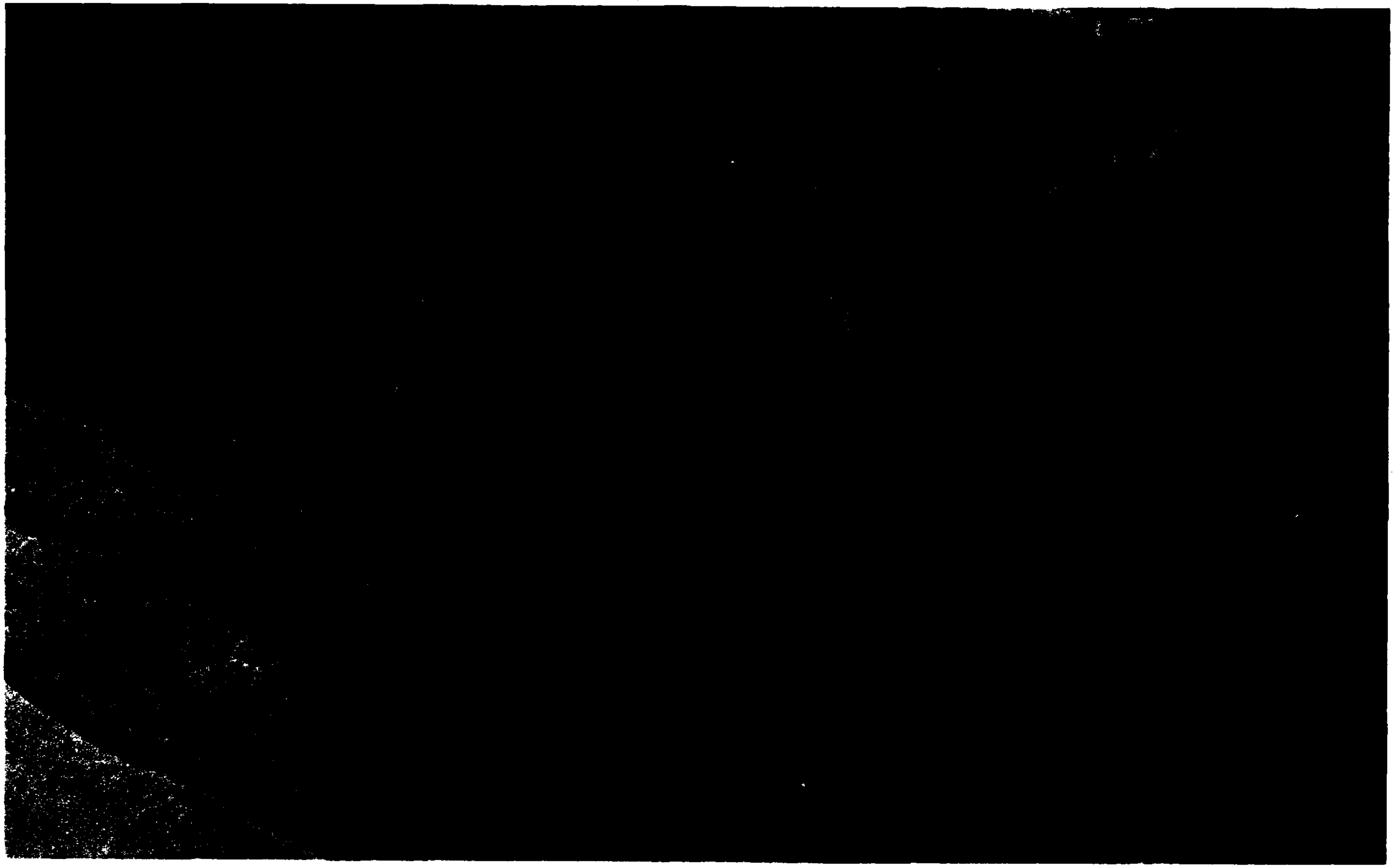


Photo 13. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from west for maximum flood; swl = +4.3 ft

Photo 14. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from west for maximum flood; swl = +4.3 ft

Photo 15. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 23-ft waves from west; swl = +6.7 ft

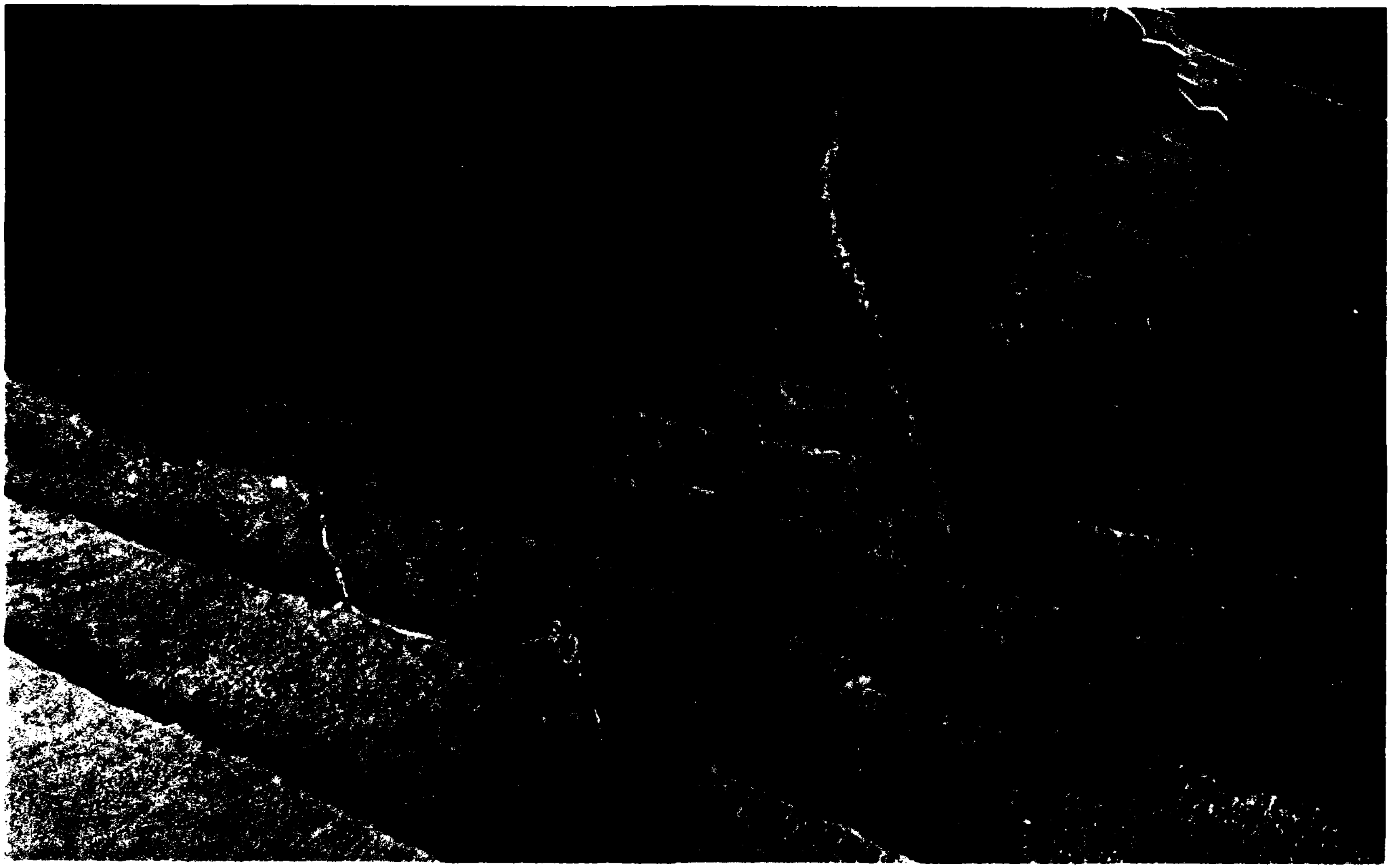


Photo 16. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from west; swl = +6.7 ft

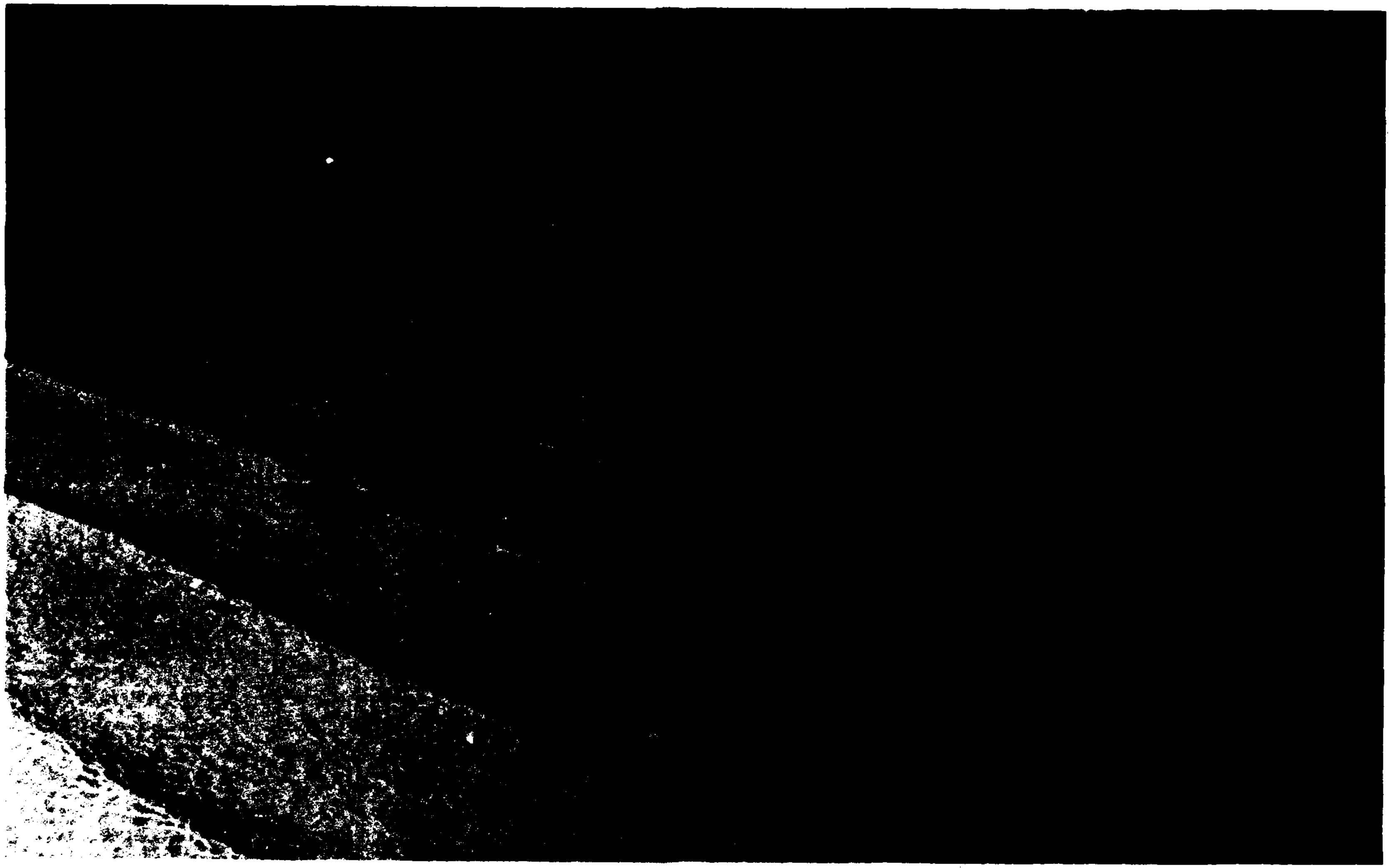


Photo 17. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from west; swl = +6.7 ft

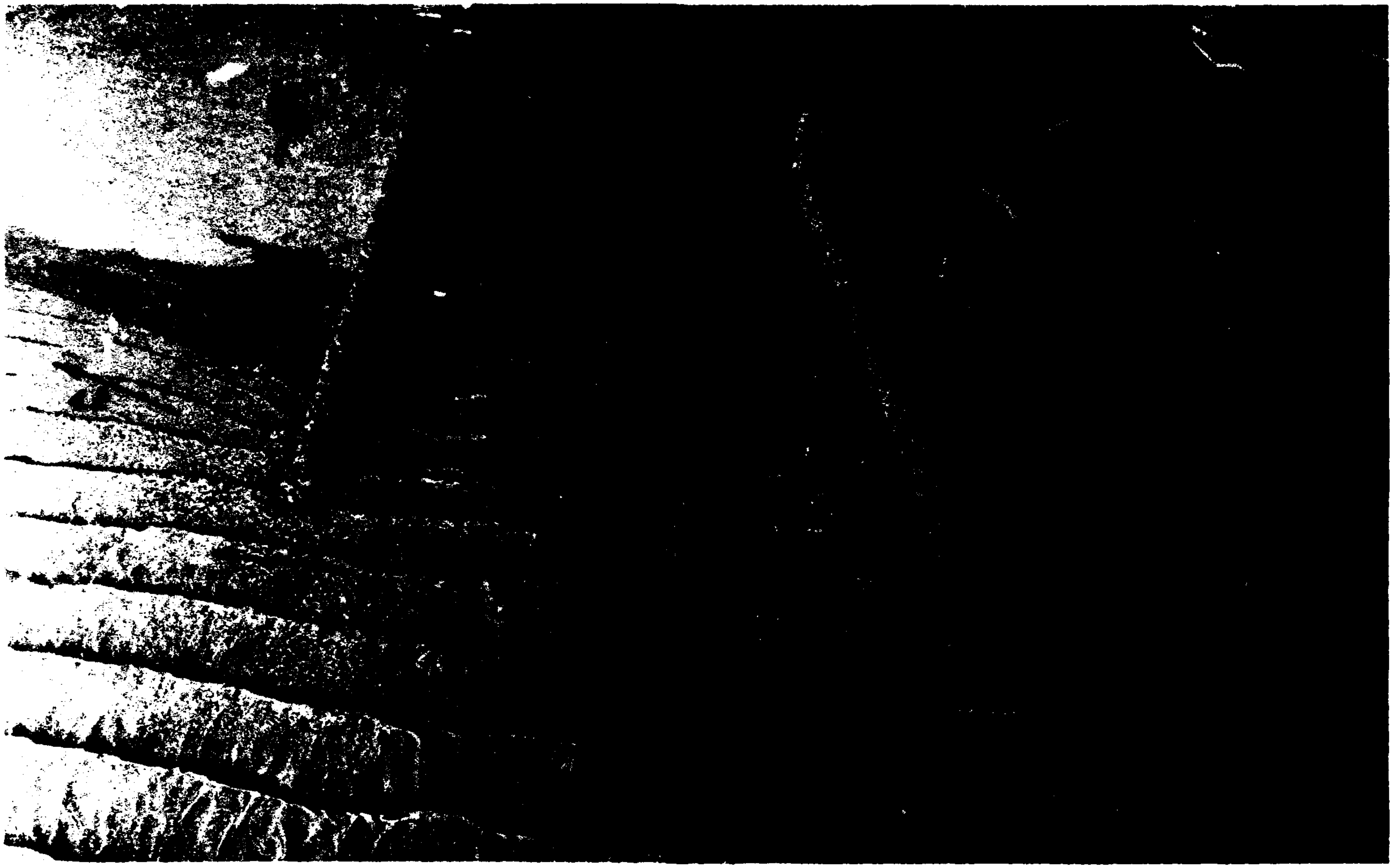


Photo 18. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 7-sec, 12-ft waves from SW for maximum ebb; swl = +1.5 ft

Photo 19. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 21-ft waves from SW for maximum ebb, swl = +1.5 ft

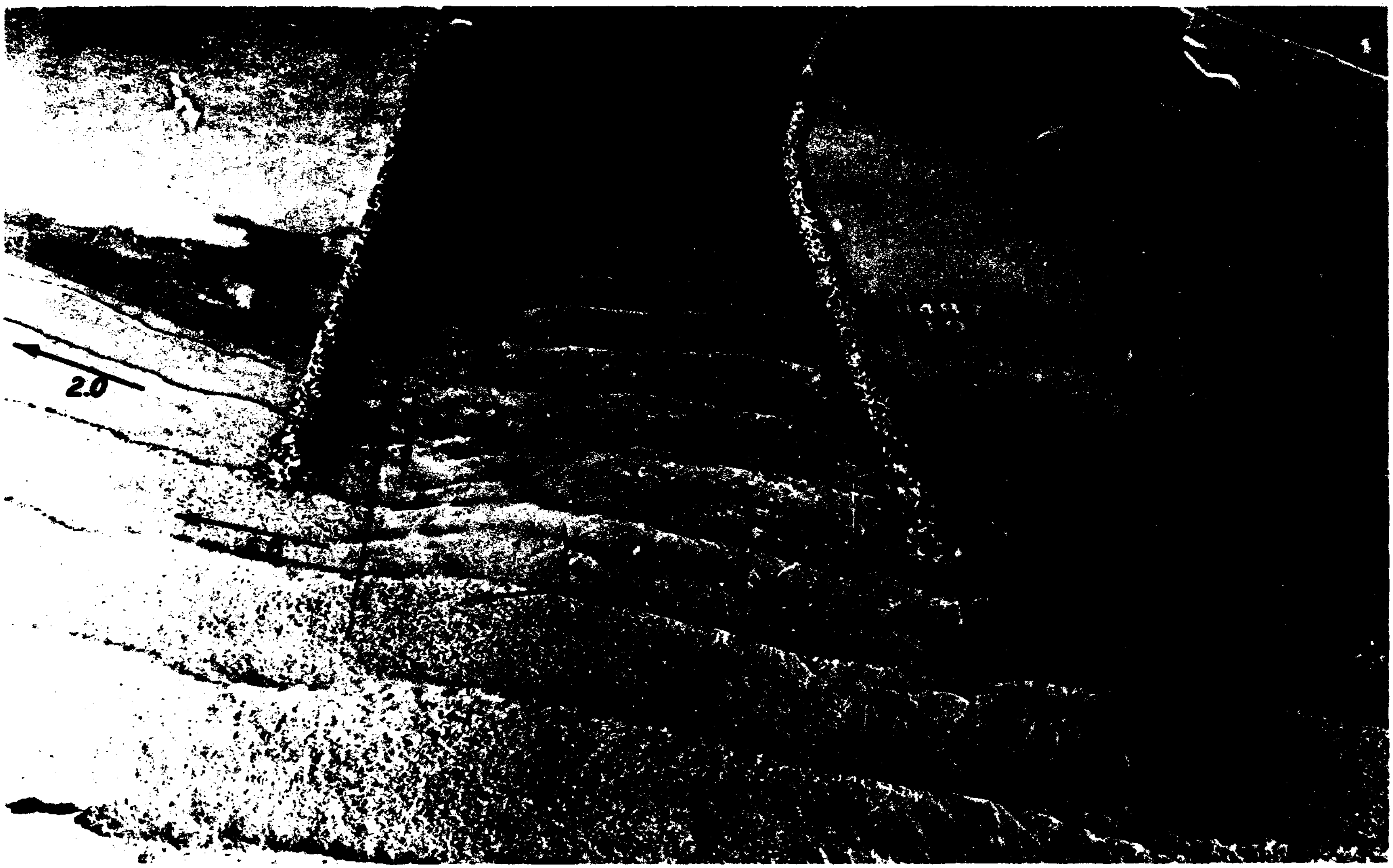


Photo 20. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 13-ft waves from SW for maximum ebb; swl = +1.5 ft

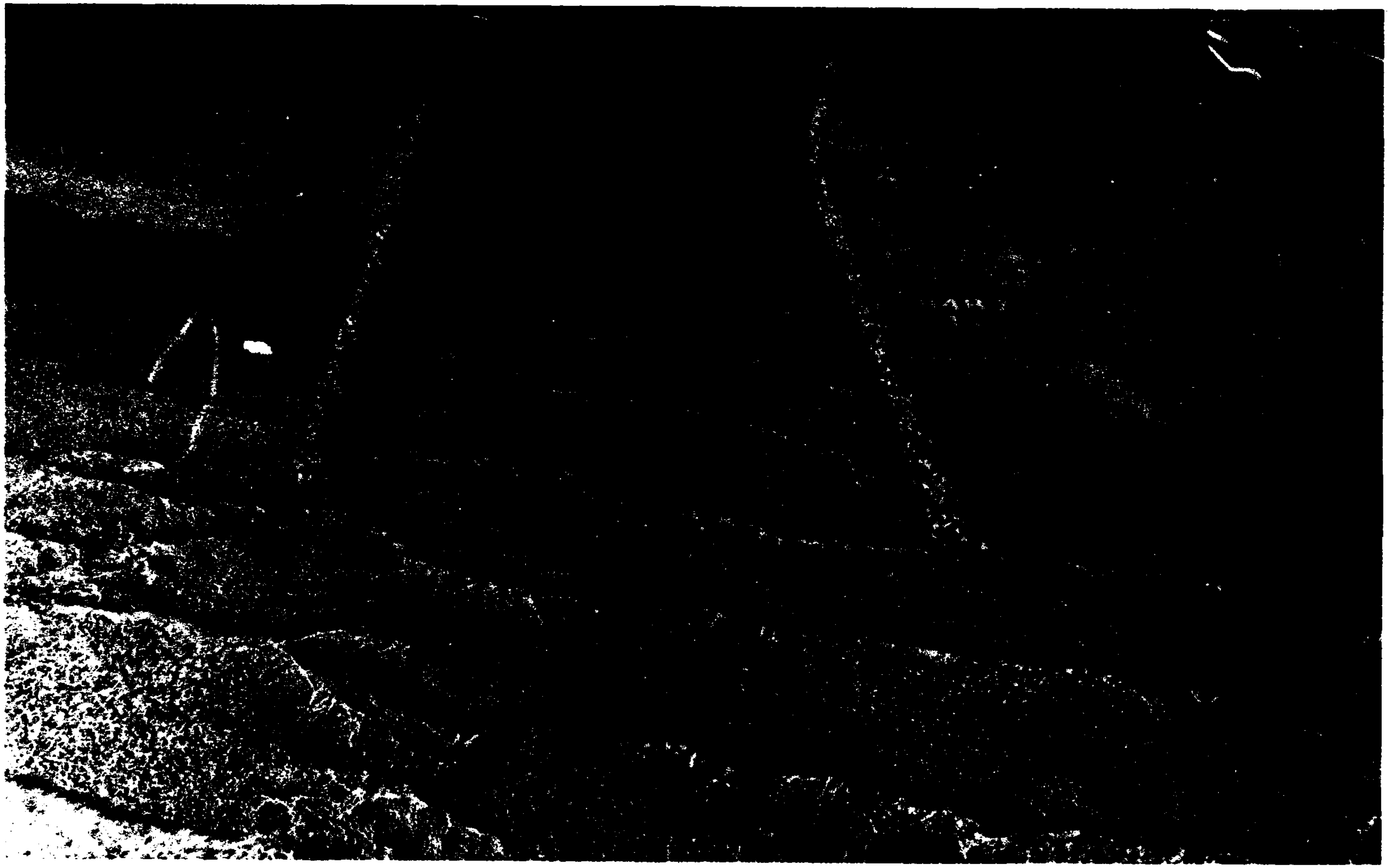


Photo 21. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 21-ft waves from SW for maximum ebb; swl = +1.5 ft

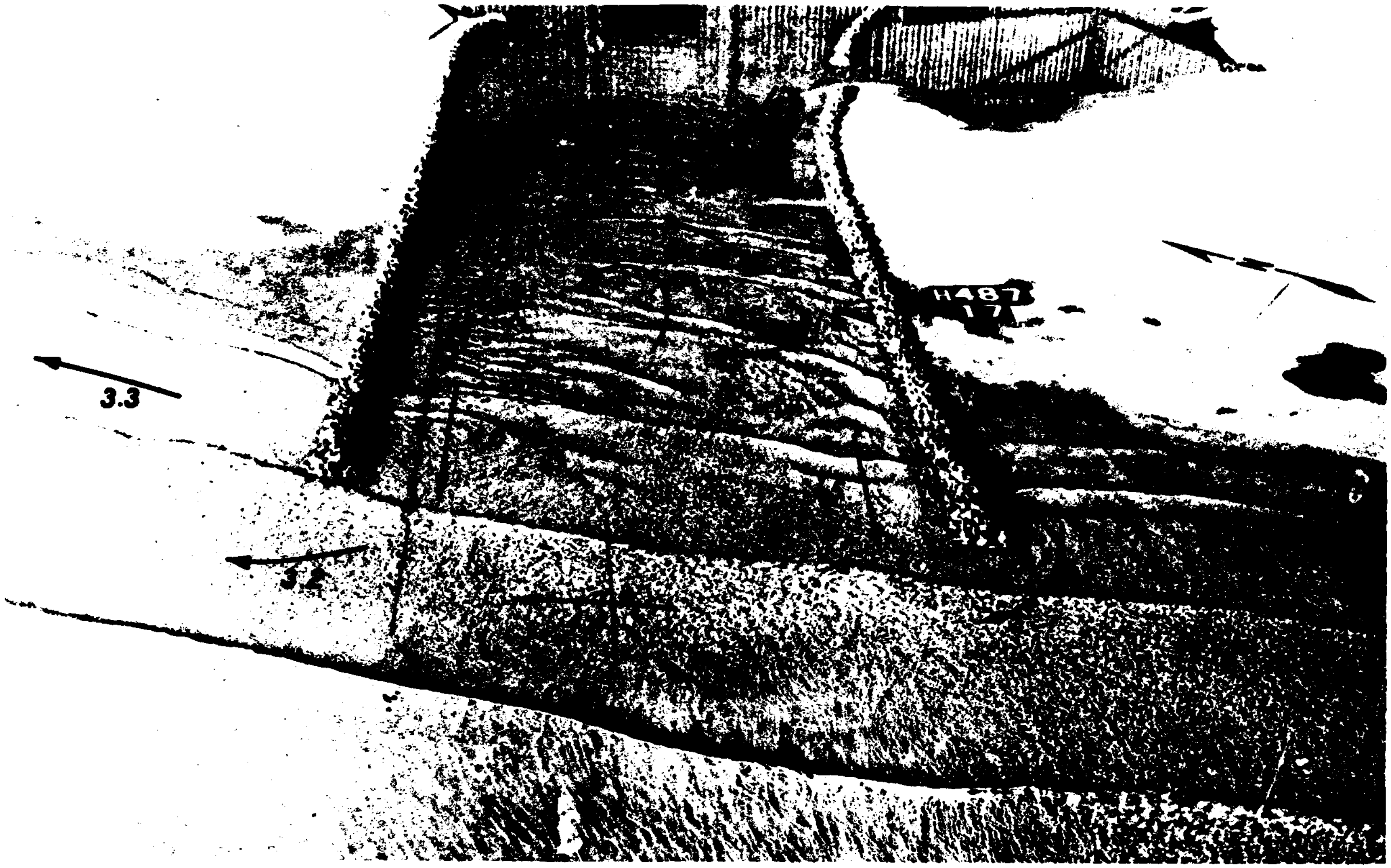


Photo 22. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 17-sec, 7-ft waves from SW for maximum ebb; swl = +1.5 ft

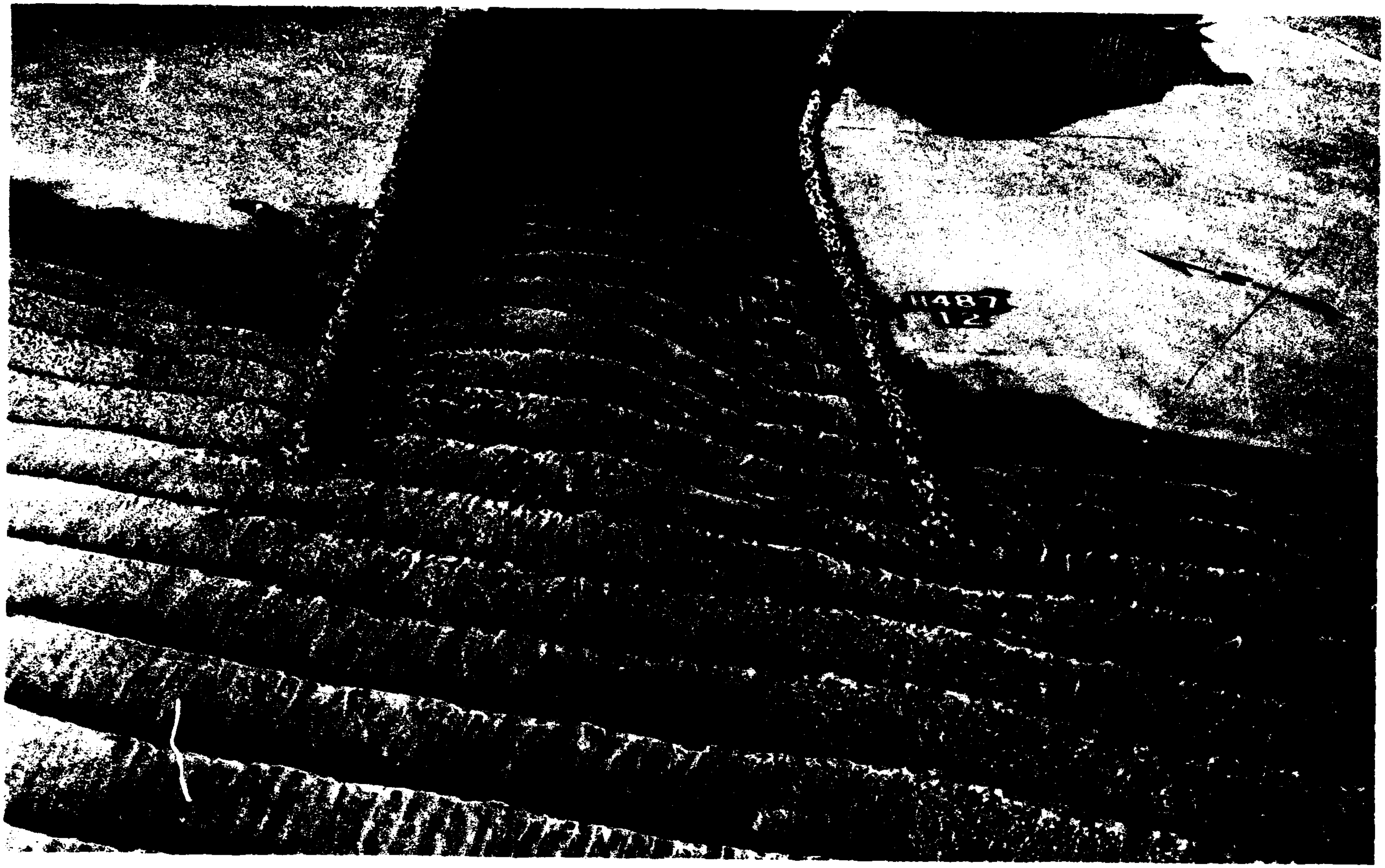


Photo 23. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 7-sec, 12-ft waves from SW for maximum flood; swl = +4.3 ft

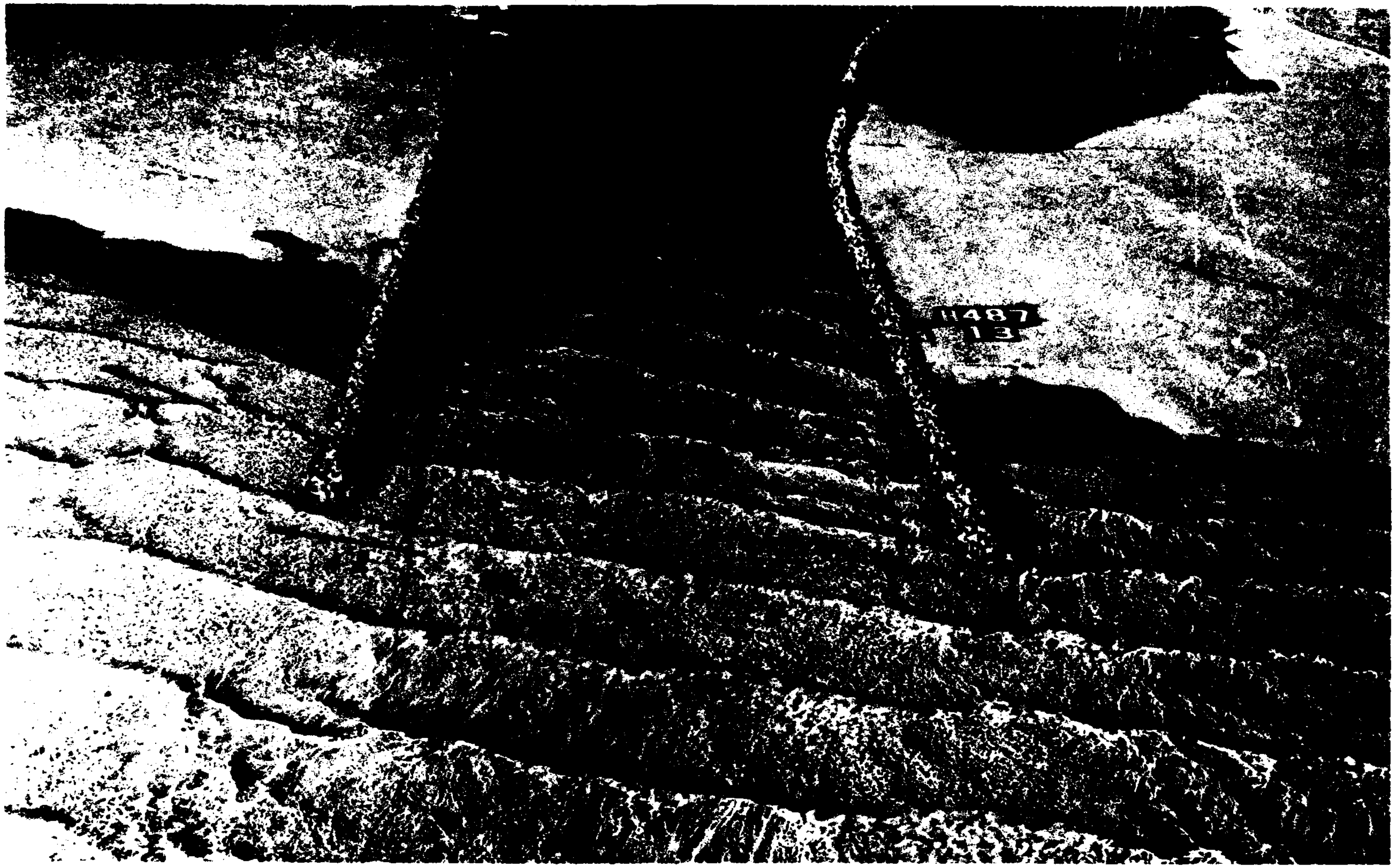


Photo 24. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 21-ft waves from SW for maximum flood; swl = +4.3 ft

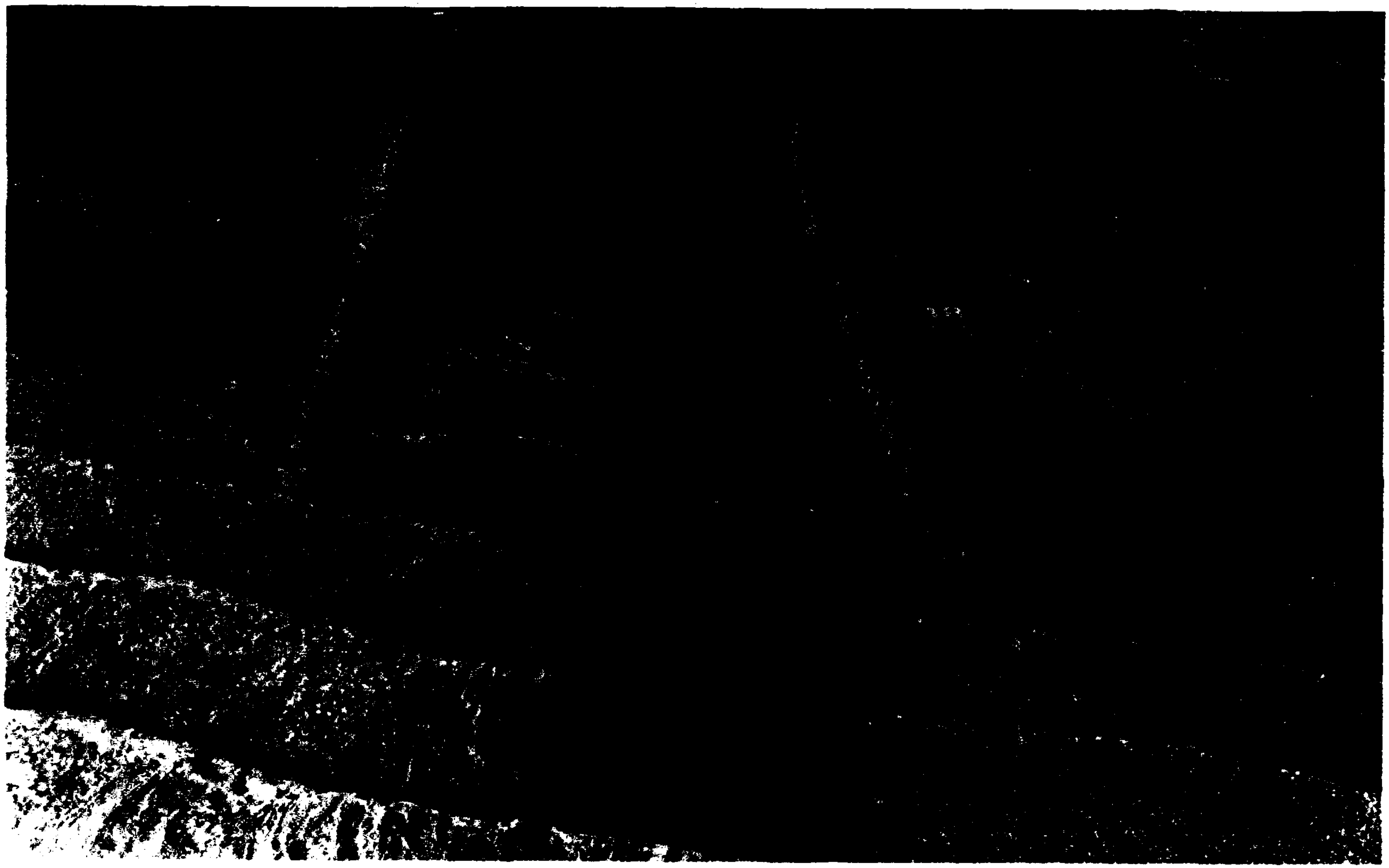


Photo 25. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 13-ft waves from SW for maximum flood; swl = +4.3 ft

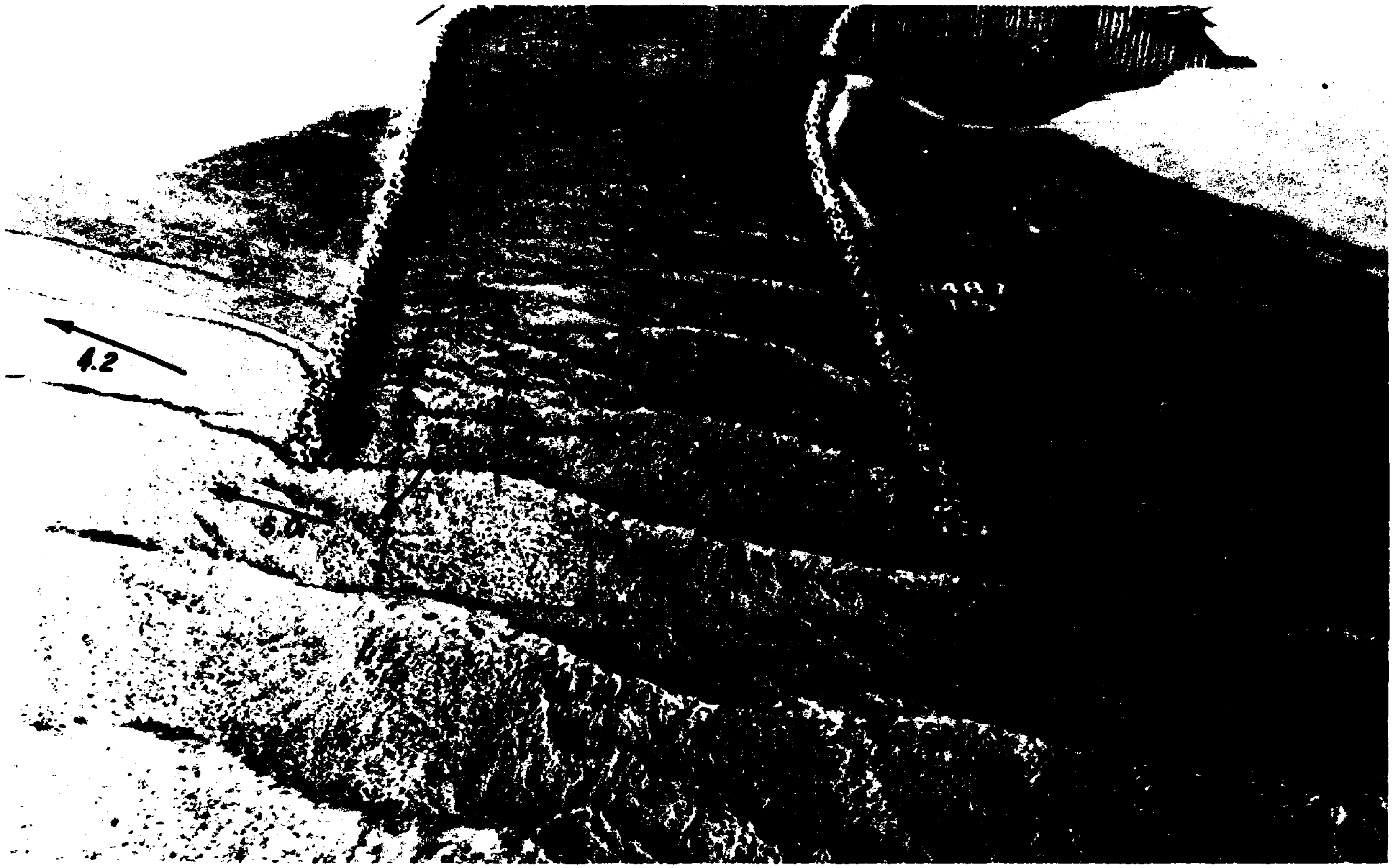


Photo 26. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 21-ft waves from SW for maximum flood; swl = +4.3 ft

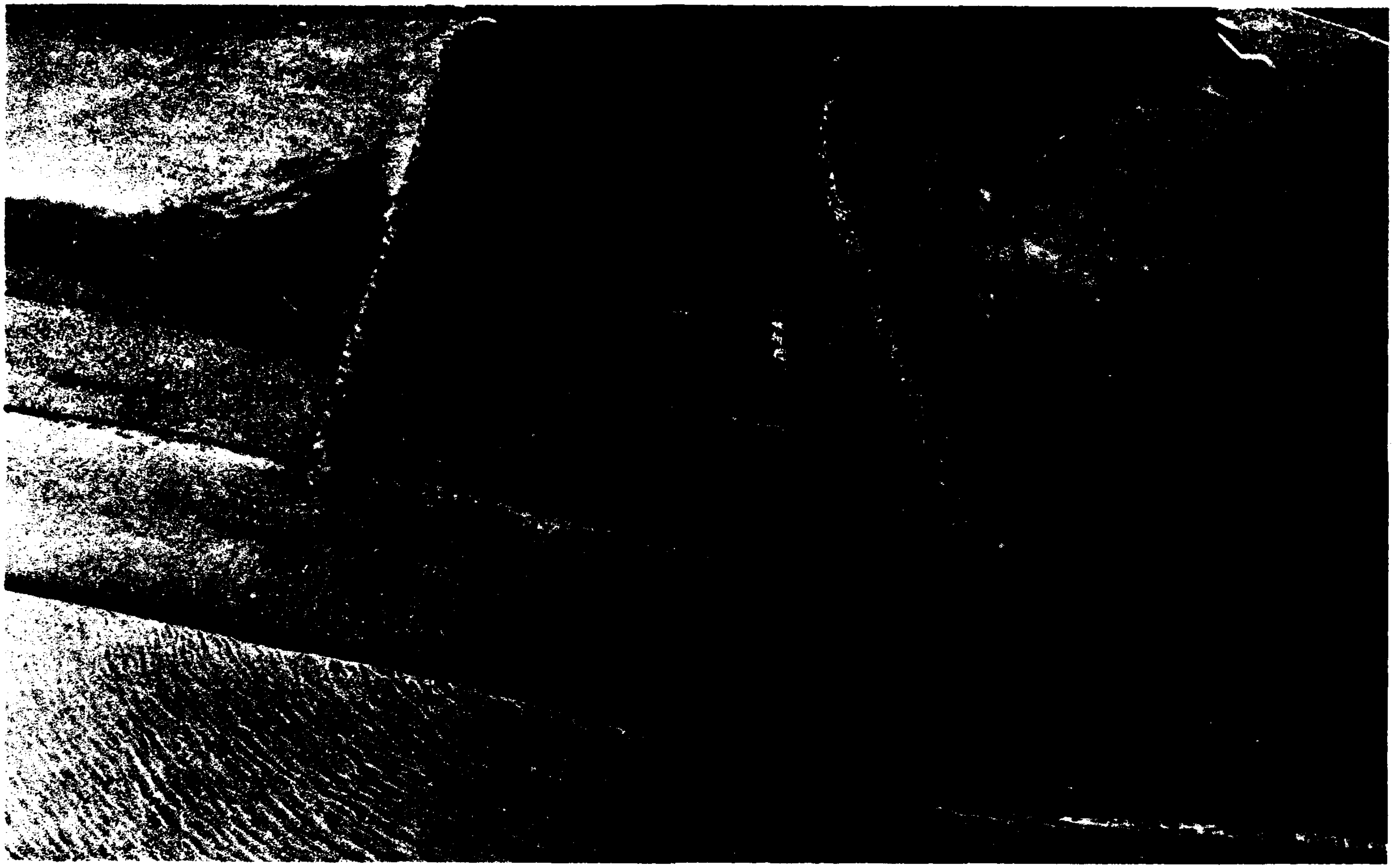


Photo 27. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 17-sec, 7-ft waves from SW for maximum flood; swl = +4.3 ft

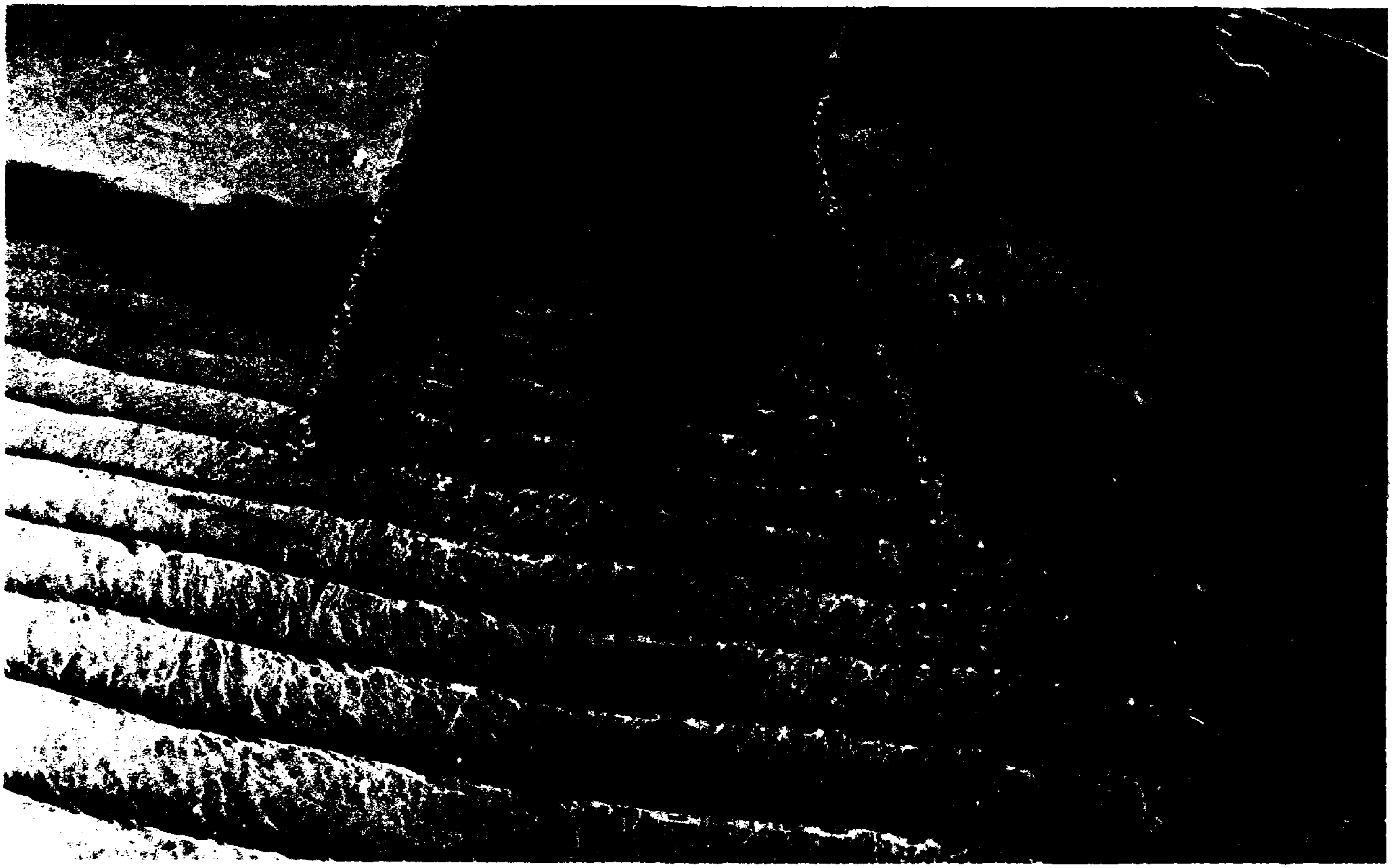


Photo 28. Typical wave patterns, current patterns, and current magnitude (prototype feet per second) for Base Test 1; 7-sec, 12-ft waves from SW; swl = +6.7 ft

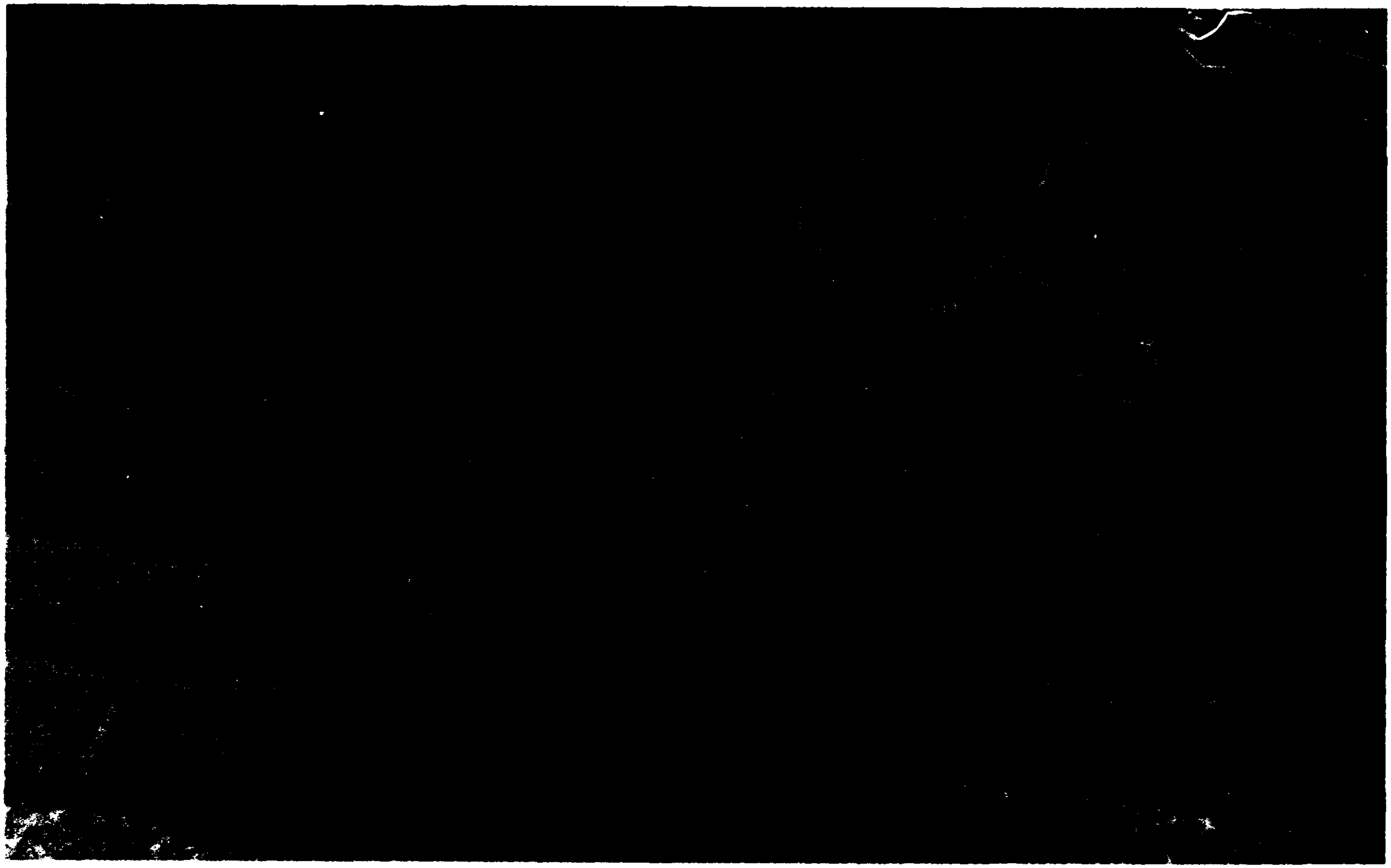


Photo 29. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 21-ft waves from SW; swl = +6.7 ft

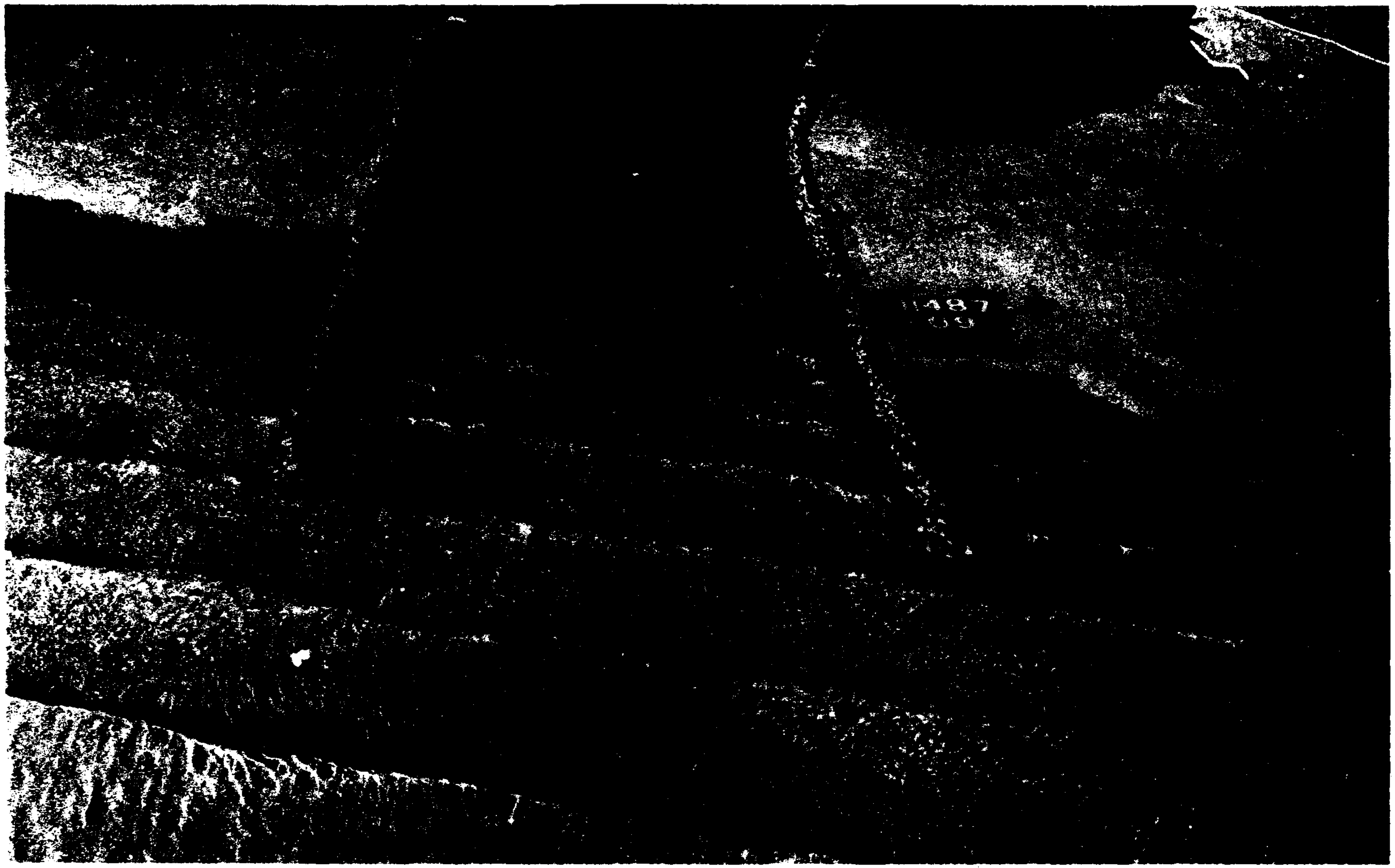


Photo 30. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 13-ft waves from SW; swl = +6.7 ft

Photo 31. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 21-ft waves from SW; swl = +6.7 ft

Photo 32. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 17-sec, 7-ft waves from SW; swl = +6.7 ft

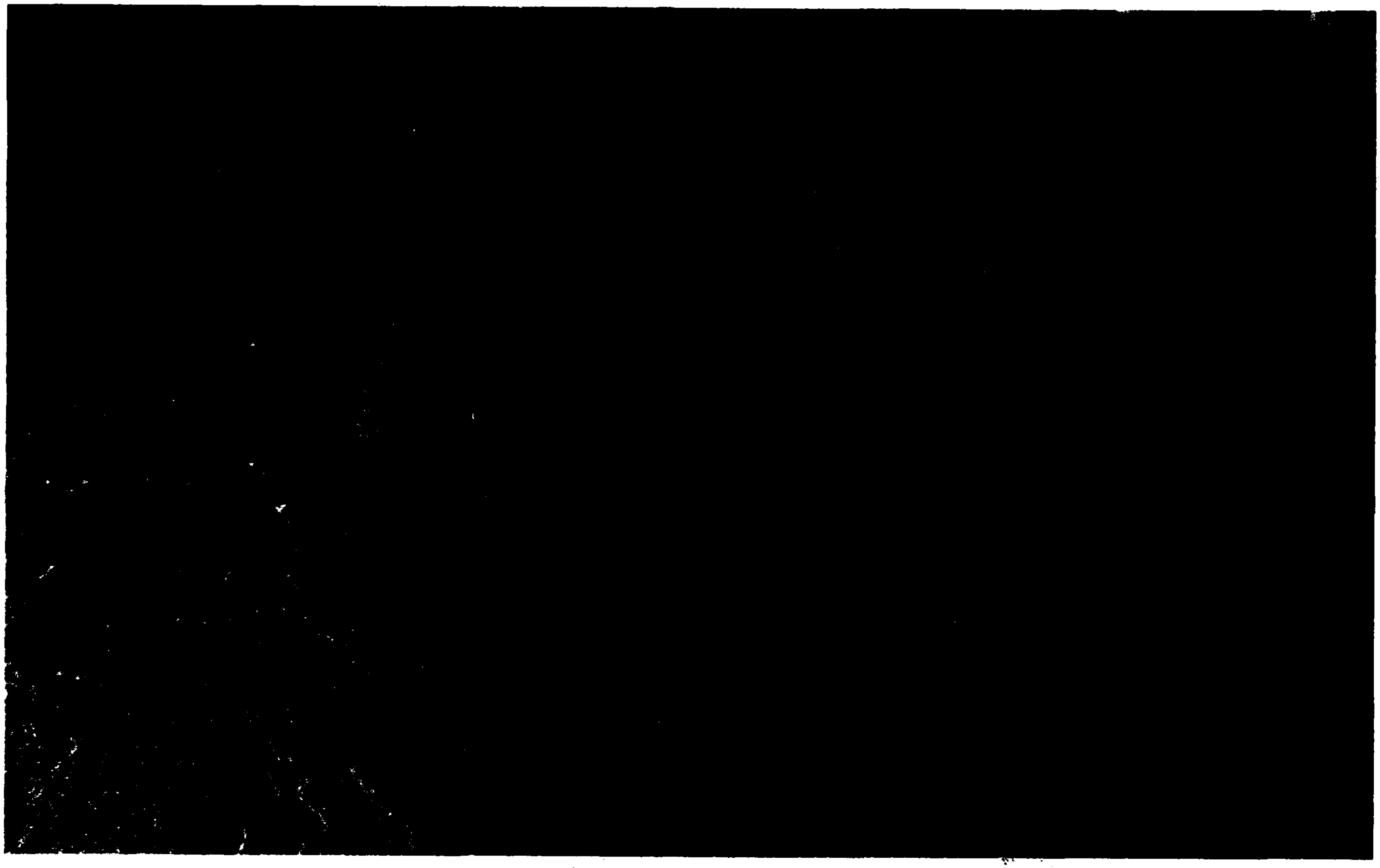


Photo 33. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 27-ft waves from SSW for maximum ebb; swl = +1.5 ft

Photo 34. Typical wave patterns, current patterns, and current mangitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from SSW for maximum ebb; swl = +1.5 ft

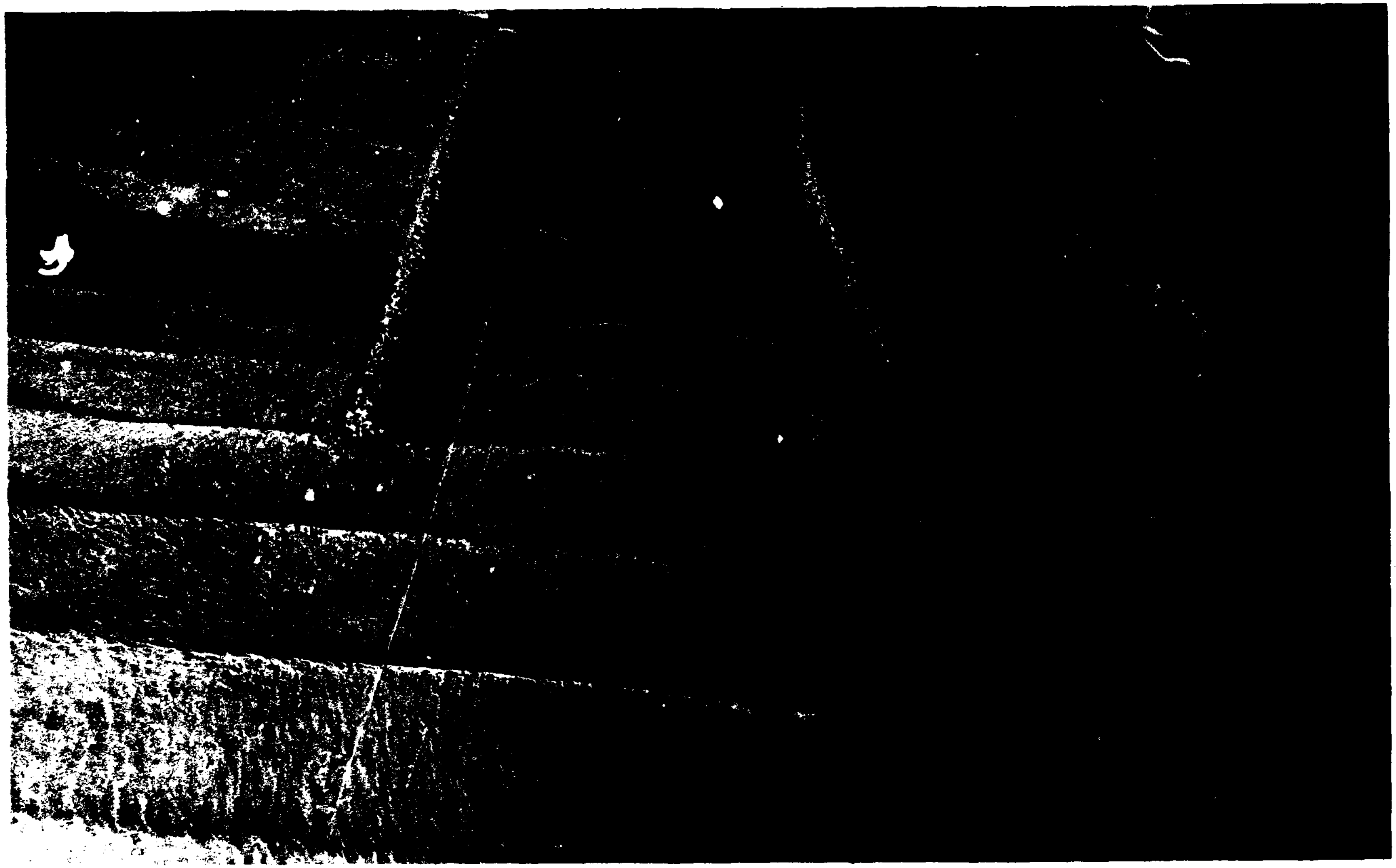


Photo 35. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from SSW for maximum ebb; swl = +1.5 ft

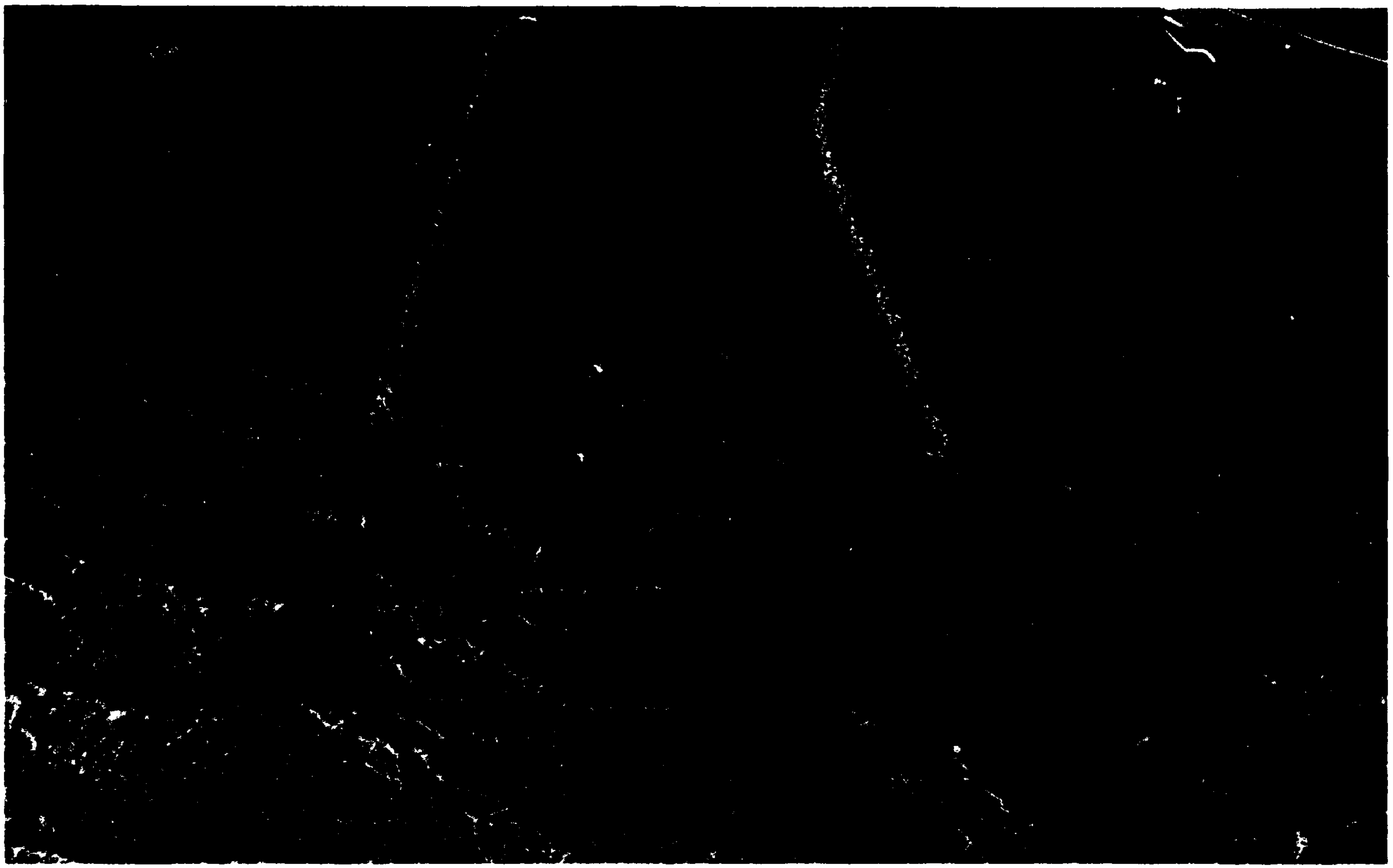


Photo 36. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 27-ft waves from SSW for maximum flood; swl = +4.3 ft

Photo 37. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from SSW for maximum flood; swl = +4.3 ft

Photo 38. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from SSW for maximum flood; swl = +4.3 ft

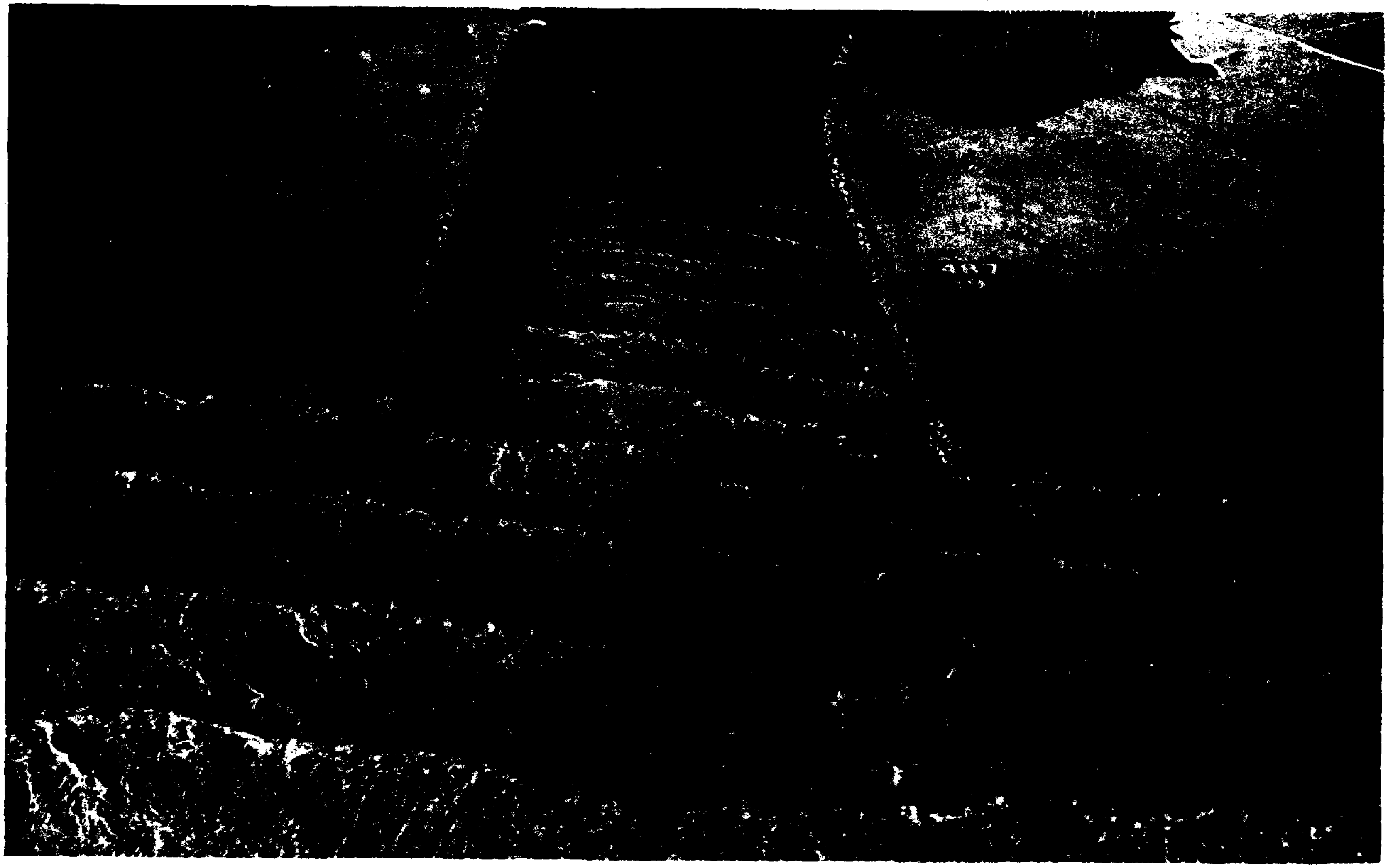


Photo 39. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 9-sec, 27-ft waves from SSW; swl = +6.7 ft

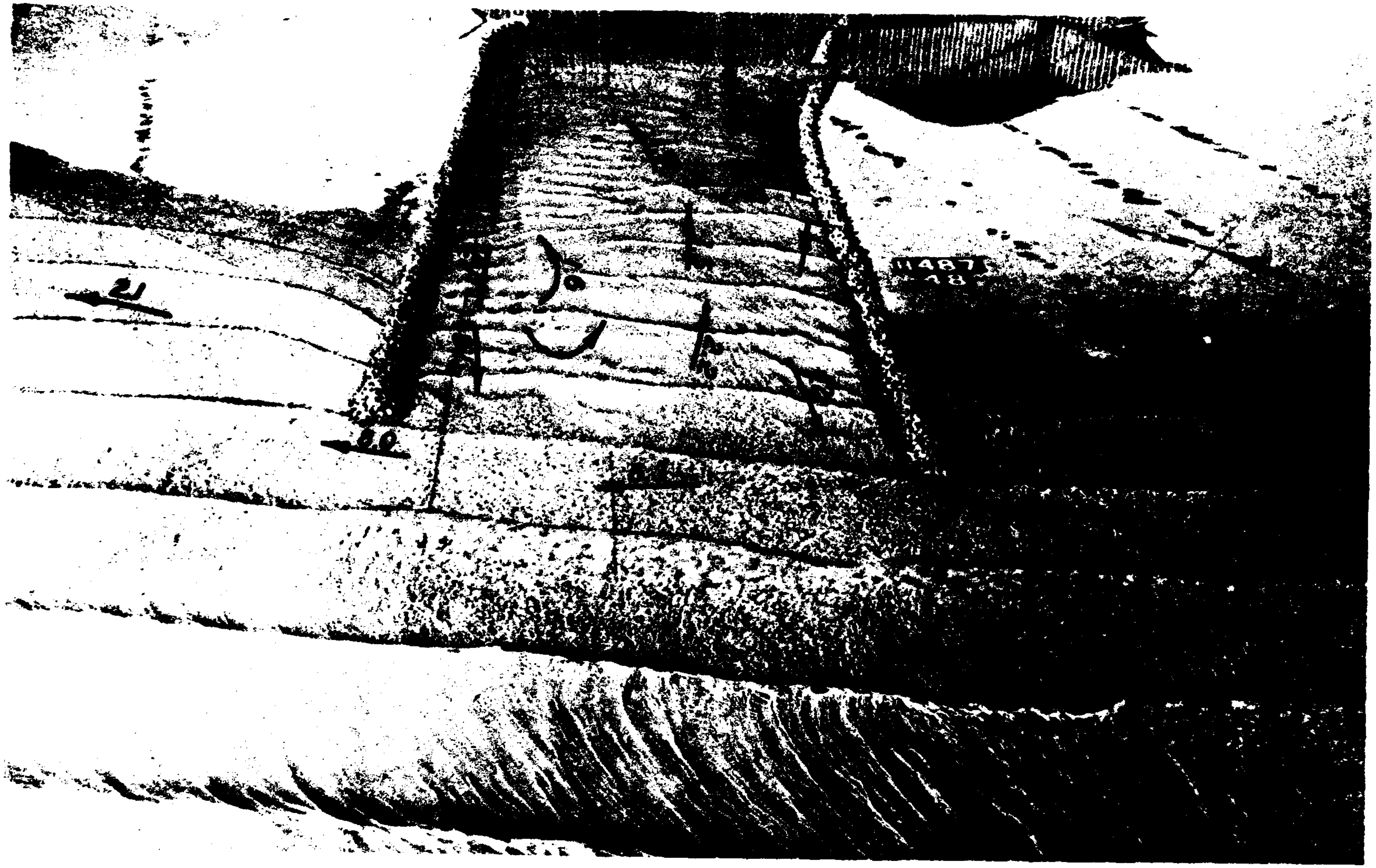


Photo 40. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 11-sec, 12-ft waves from SSW; swl = +6.7 ft

Photo 41. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 1; 13-sec, 7-ft waves from SSW; swl = +6.7 ft

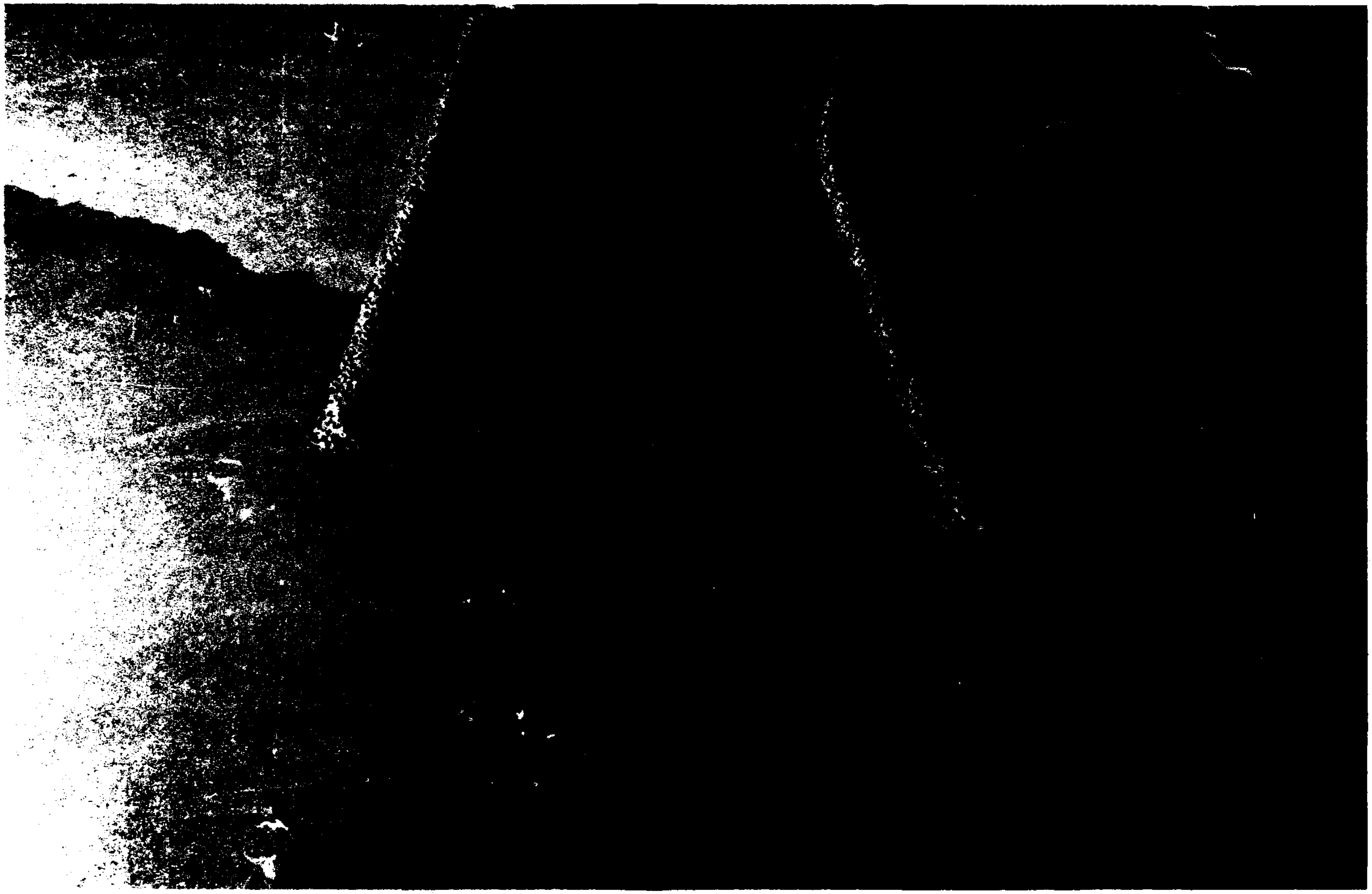


Photo 42. Shoaling pattern for a 100,000-cfs river discharge for Base Test 1

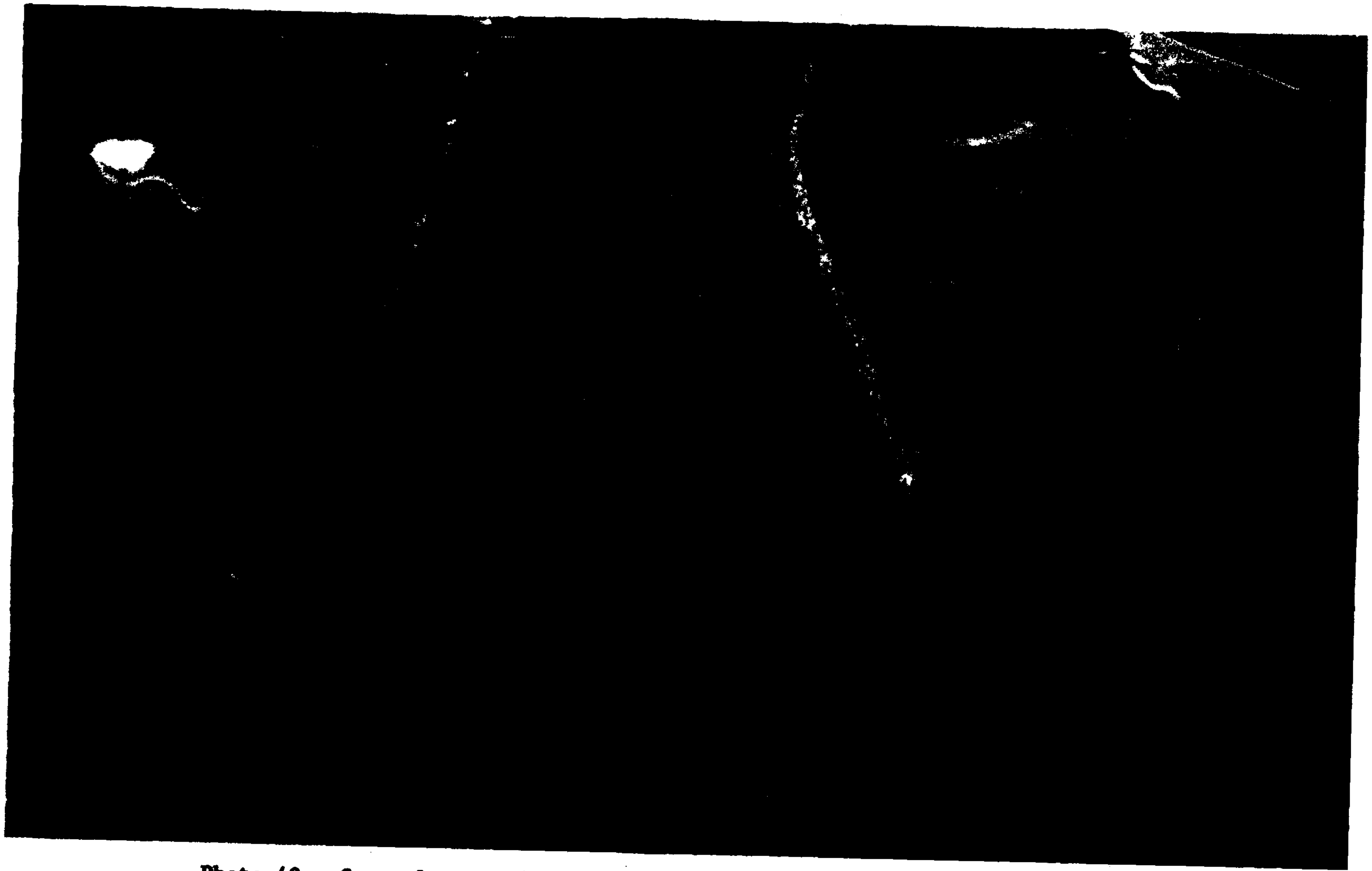


Photo 43. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW with Base Test 1 installed; swl = 0.0 ft

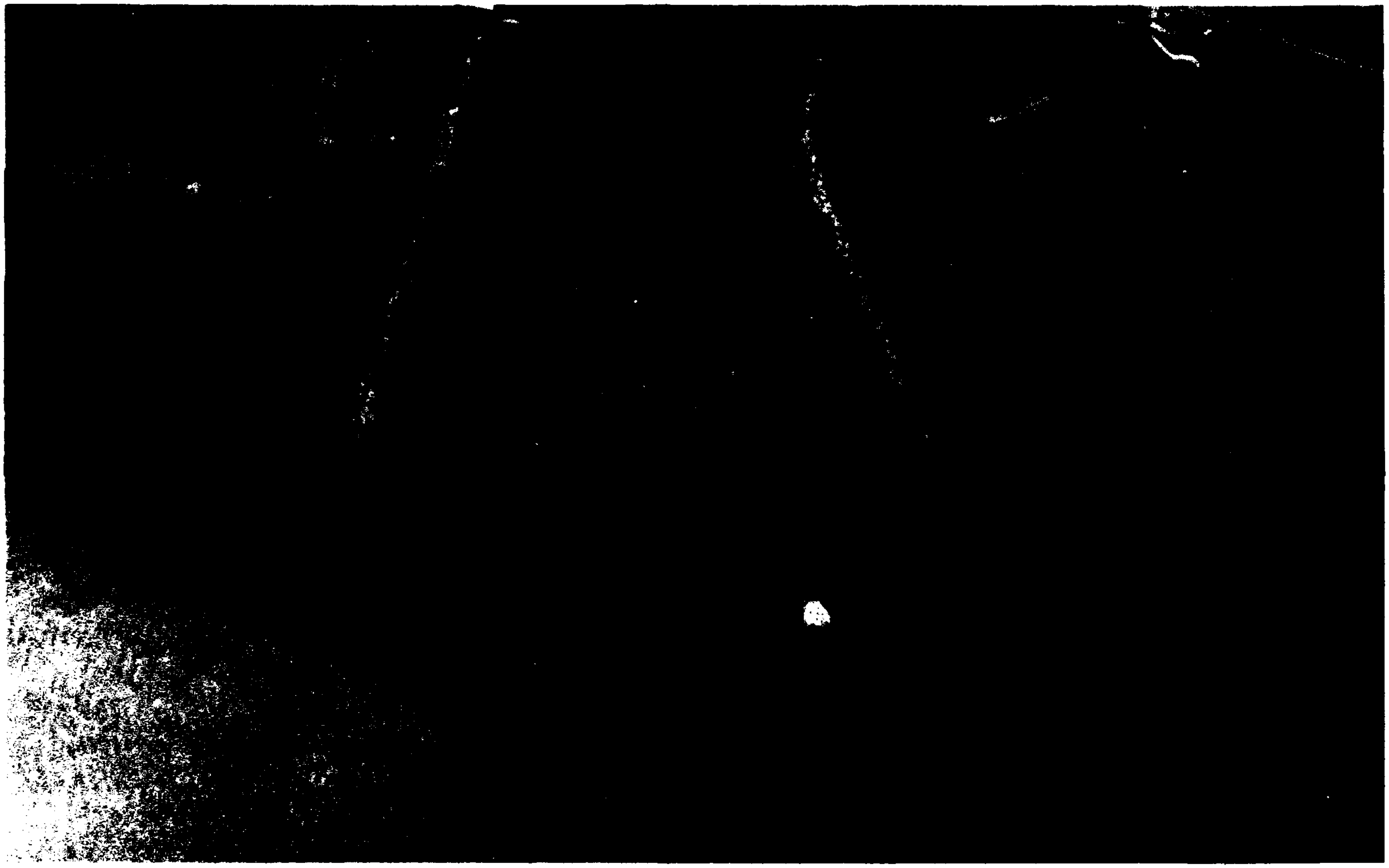


Photo 44. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW with Base Test 1 installed; swl = 0.0 ft

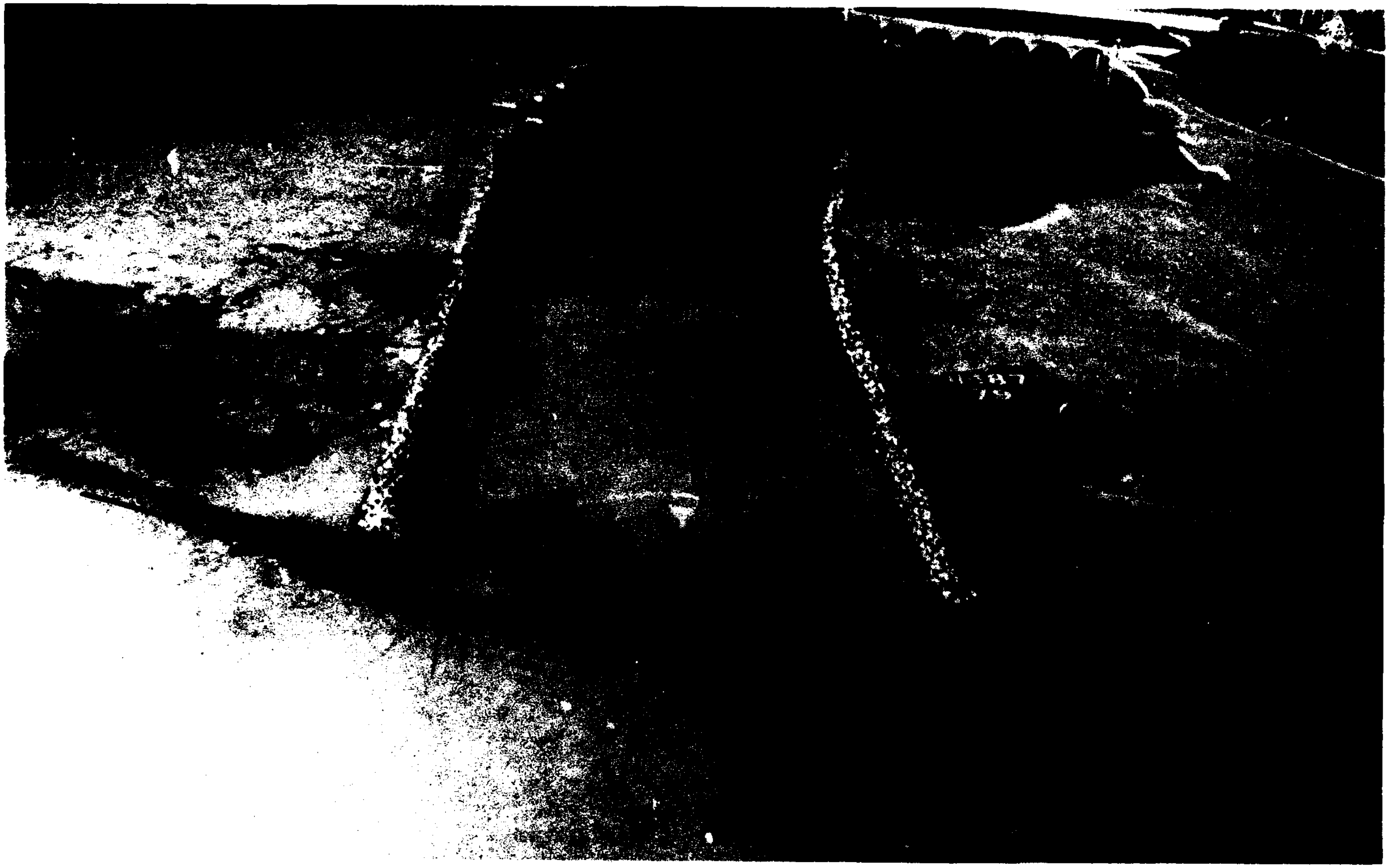


Photo 45. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW with Base Test 1 installed; swl = 0.0 ft

Photo 46. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

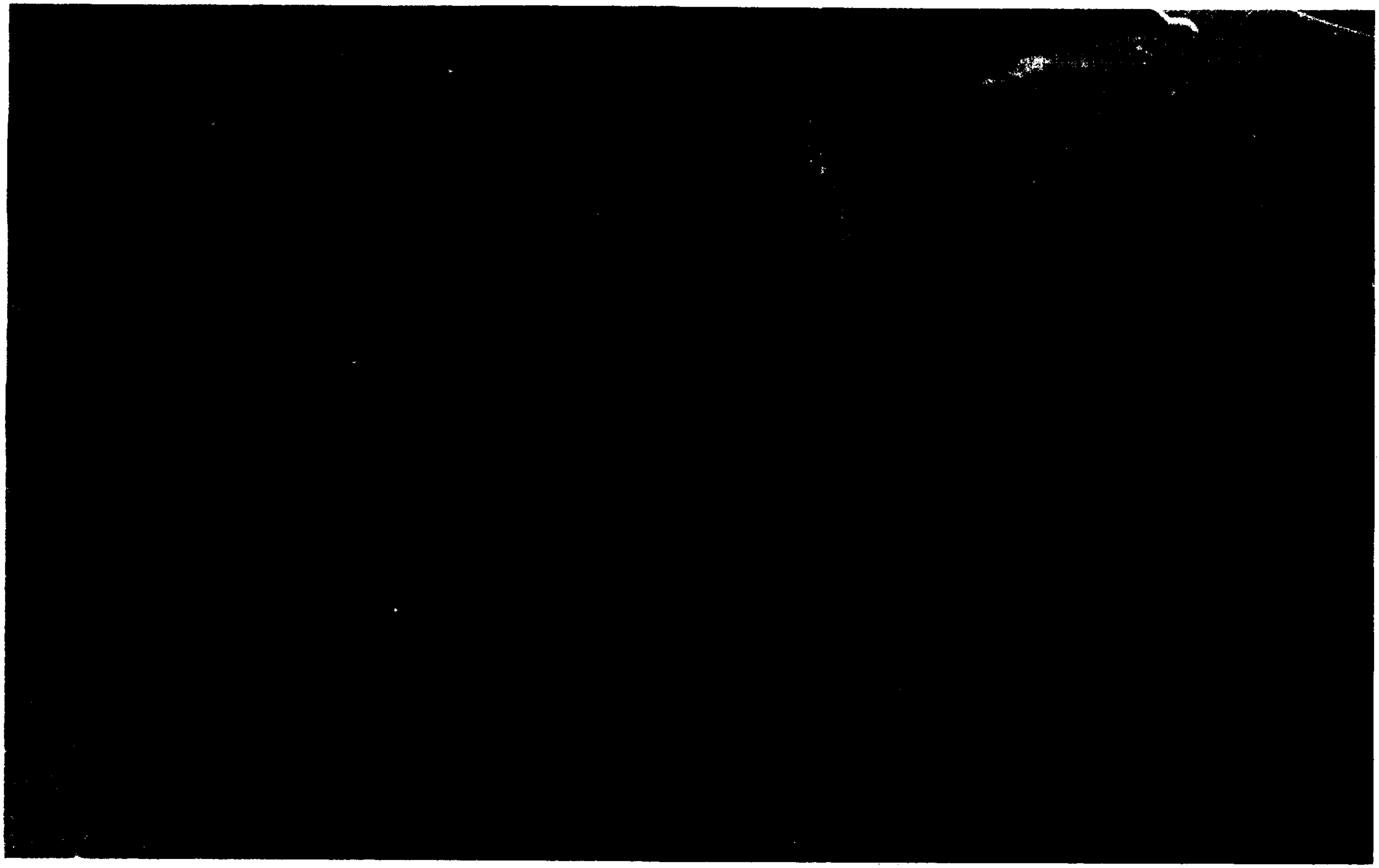


Photo 47. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

Photo 48. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

Photo 49. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for maximum flood with Base Test 1 installed; swl = +4.3 ft

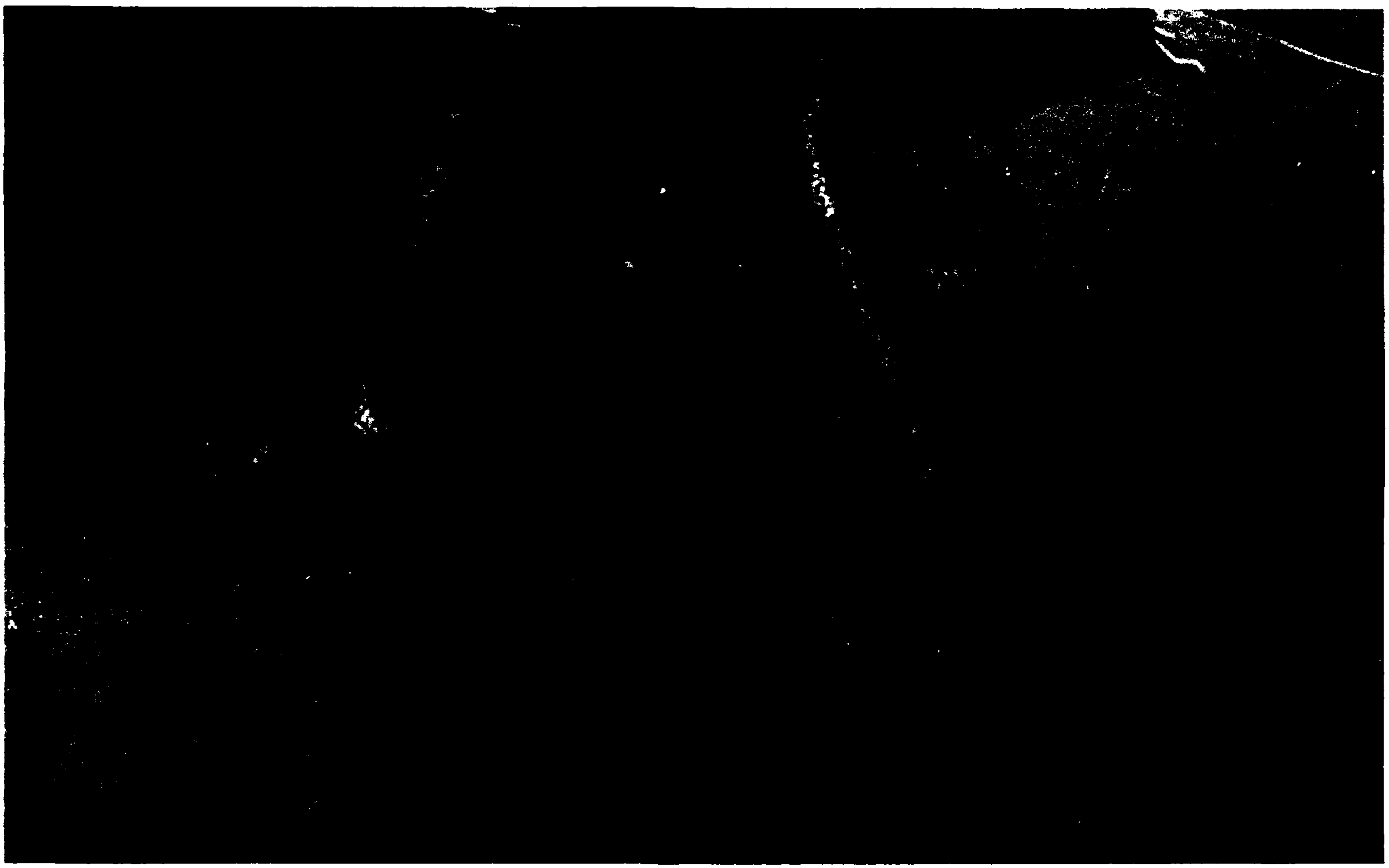


Photo 50. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum flood with Base Test 1 installed; swl = +4.3 ft

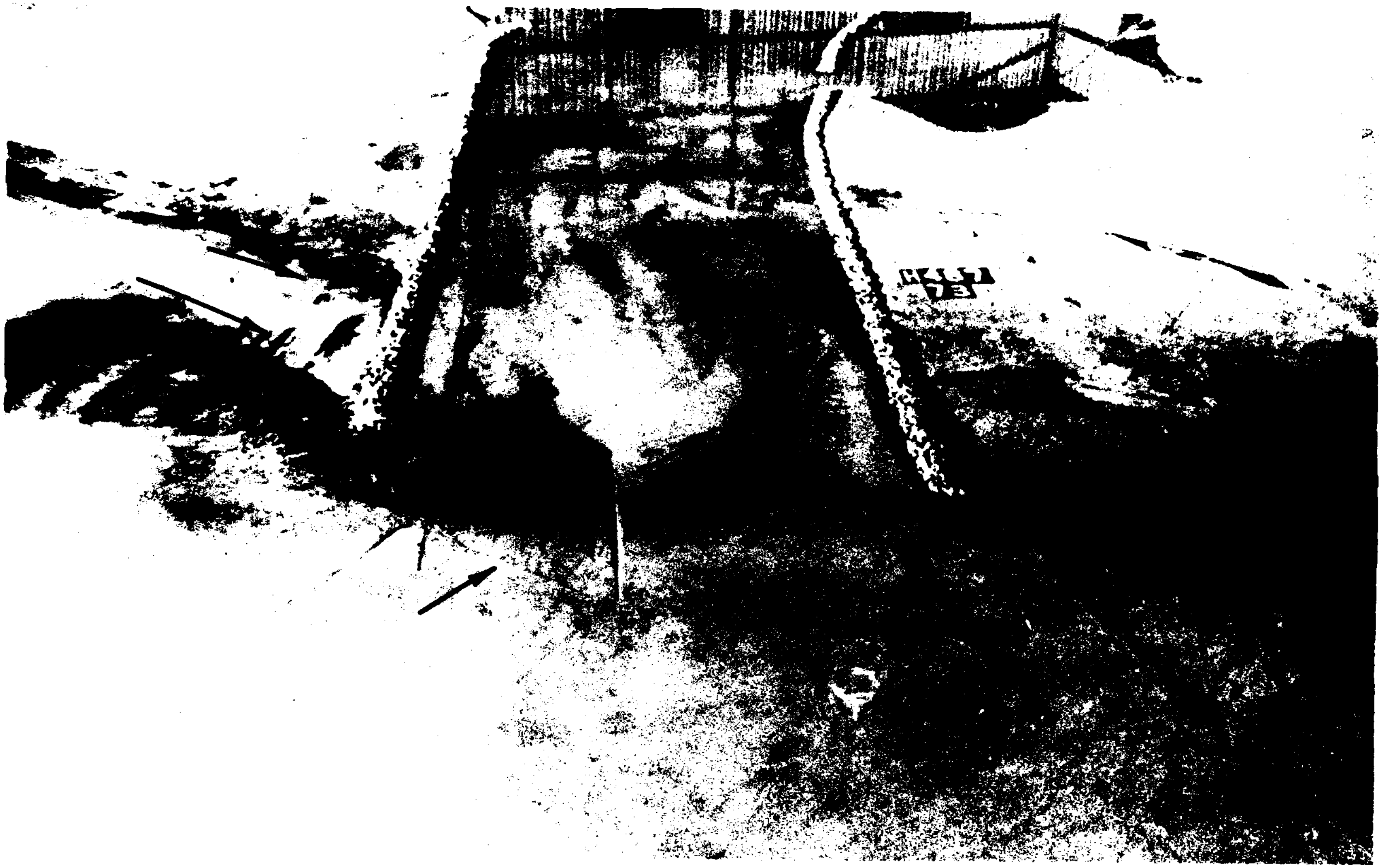


Photo 51. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for maximum flood with Base Test 1 installed; swl = +4.3 ft

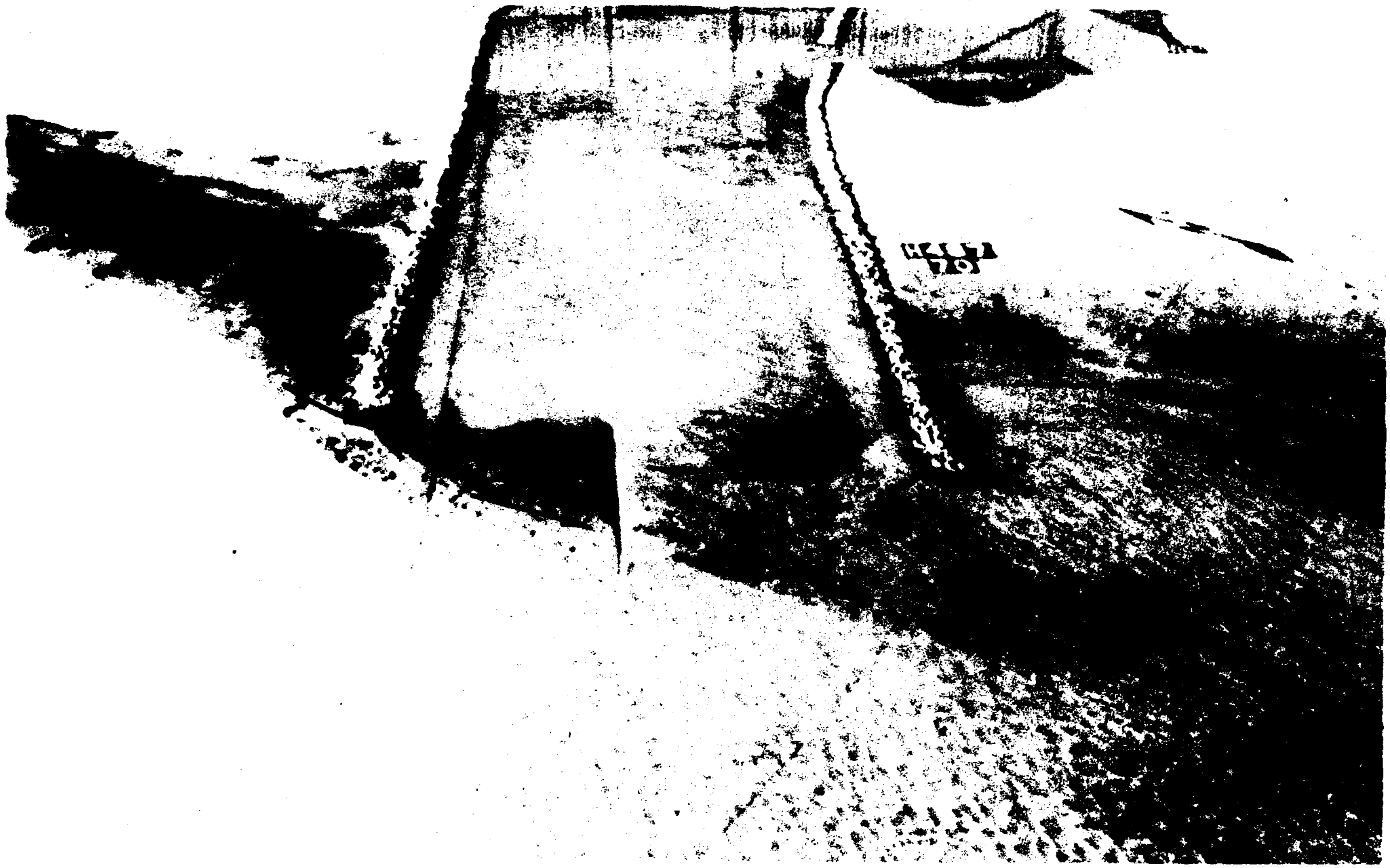


Photo 52. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW with Base Test 1 installed; swl = +6.7 ft

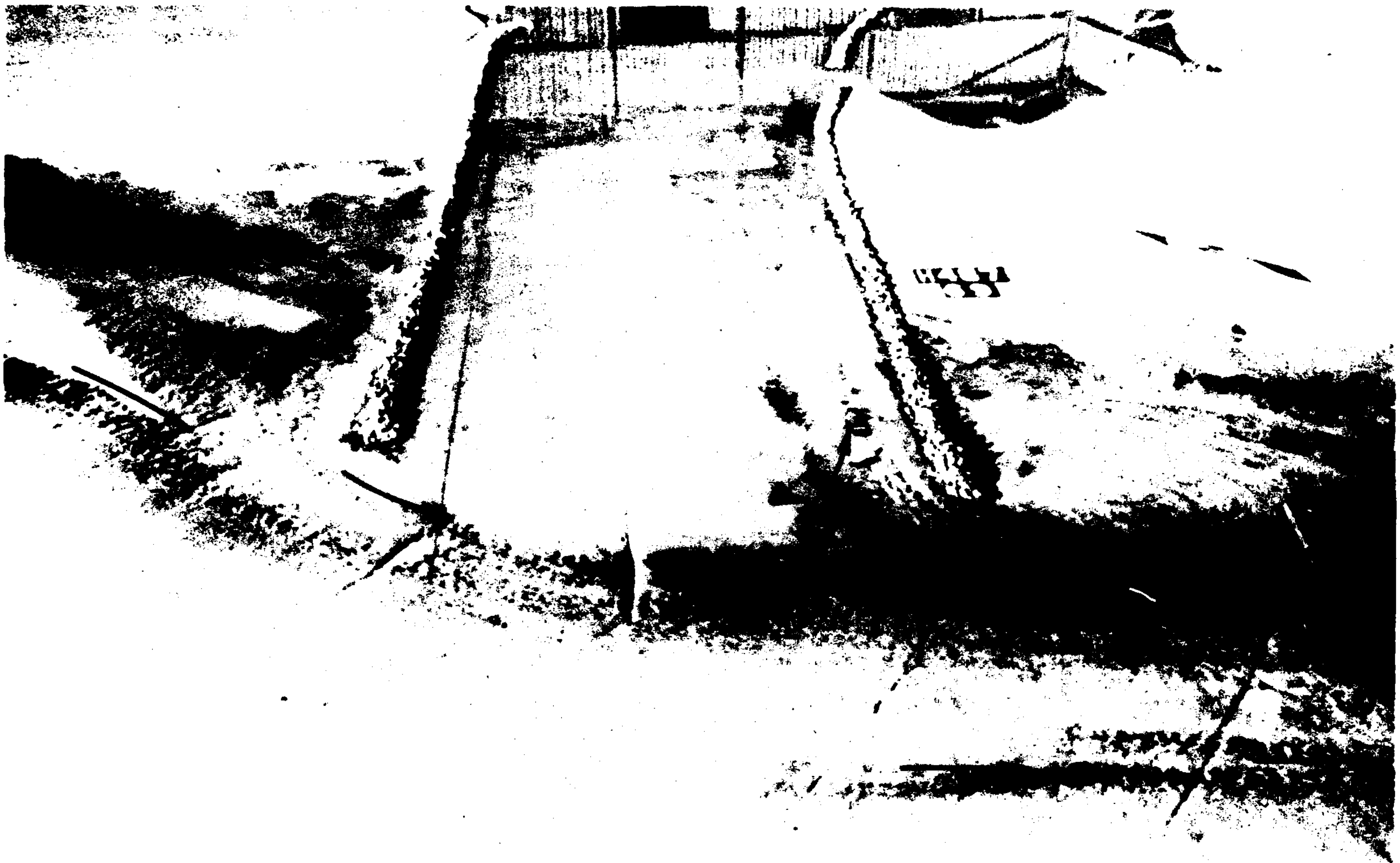


Photo 53. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW with Base Test 1 installed; swl = +6.7 ft

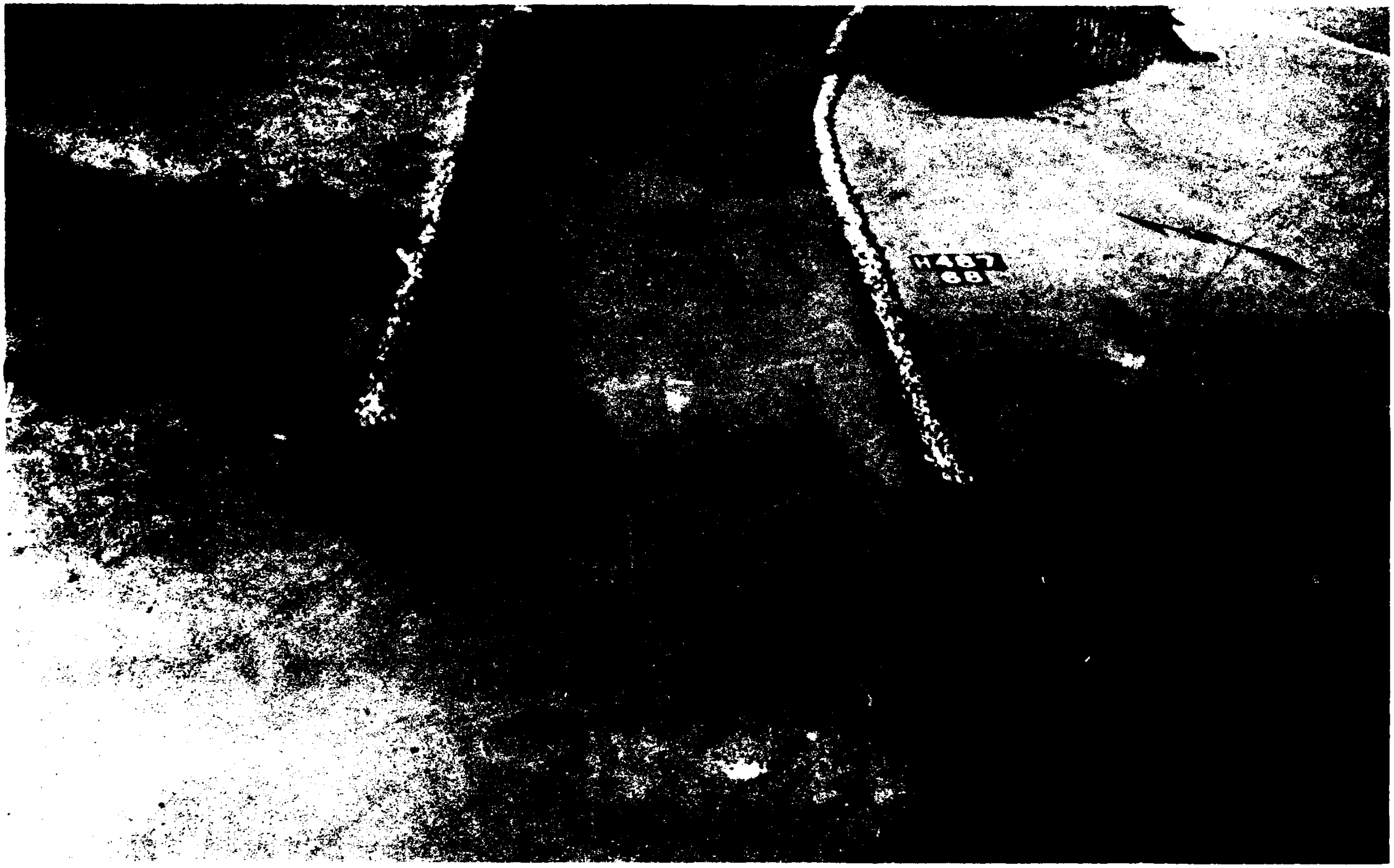


Photo 54. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW with Base Test 1 installed; swl = +6.7 ft

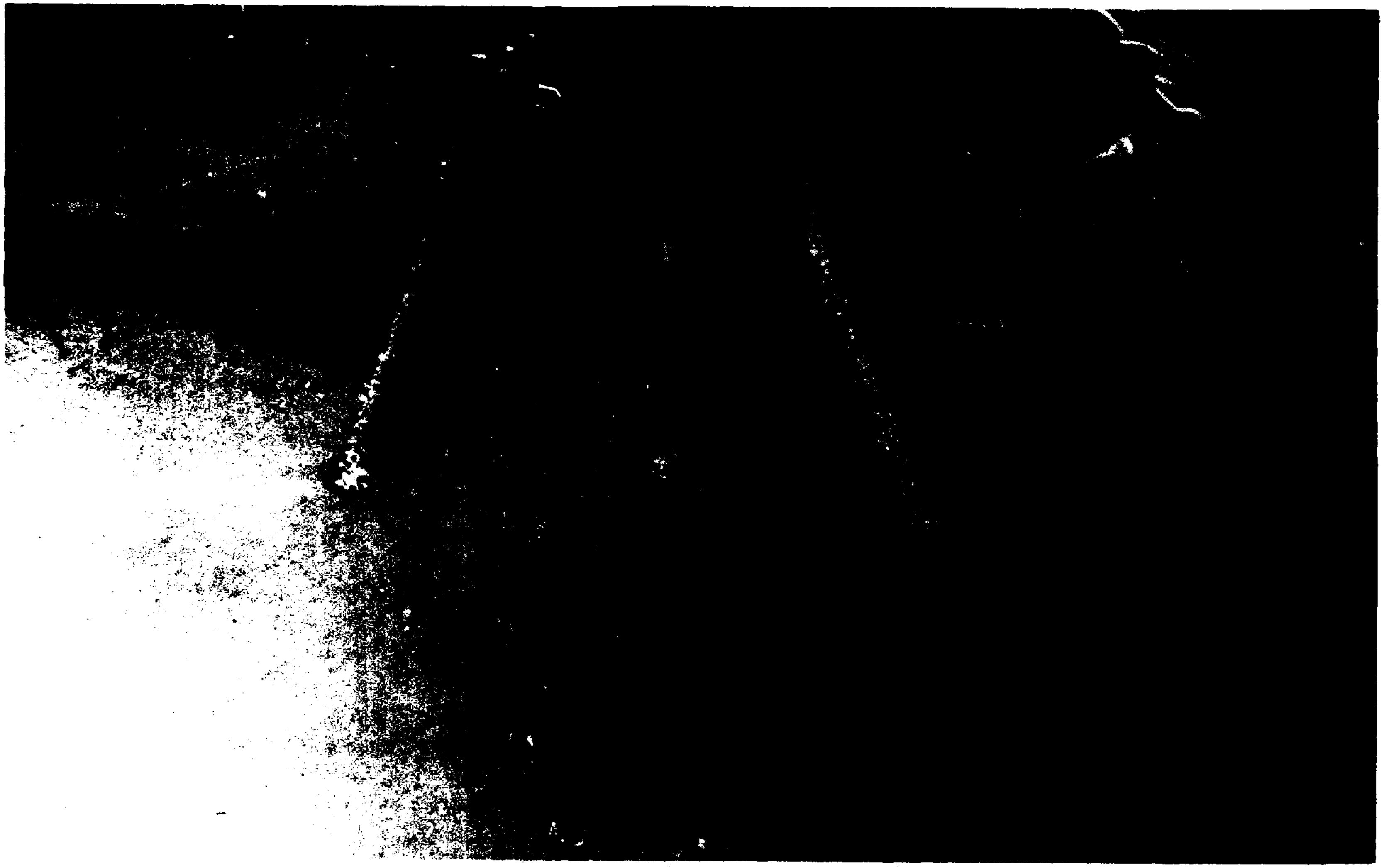


Photo 55. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west with Base Test 1 installed; swl = 0.0 ft

Photo 56. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west with Base Test 1 installed; swl = 0.0 ft

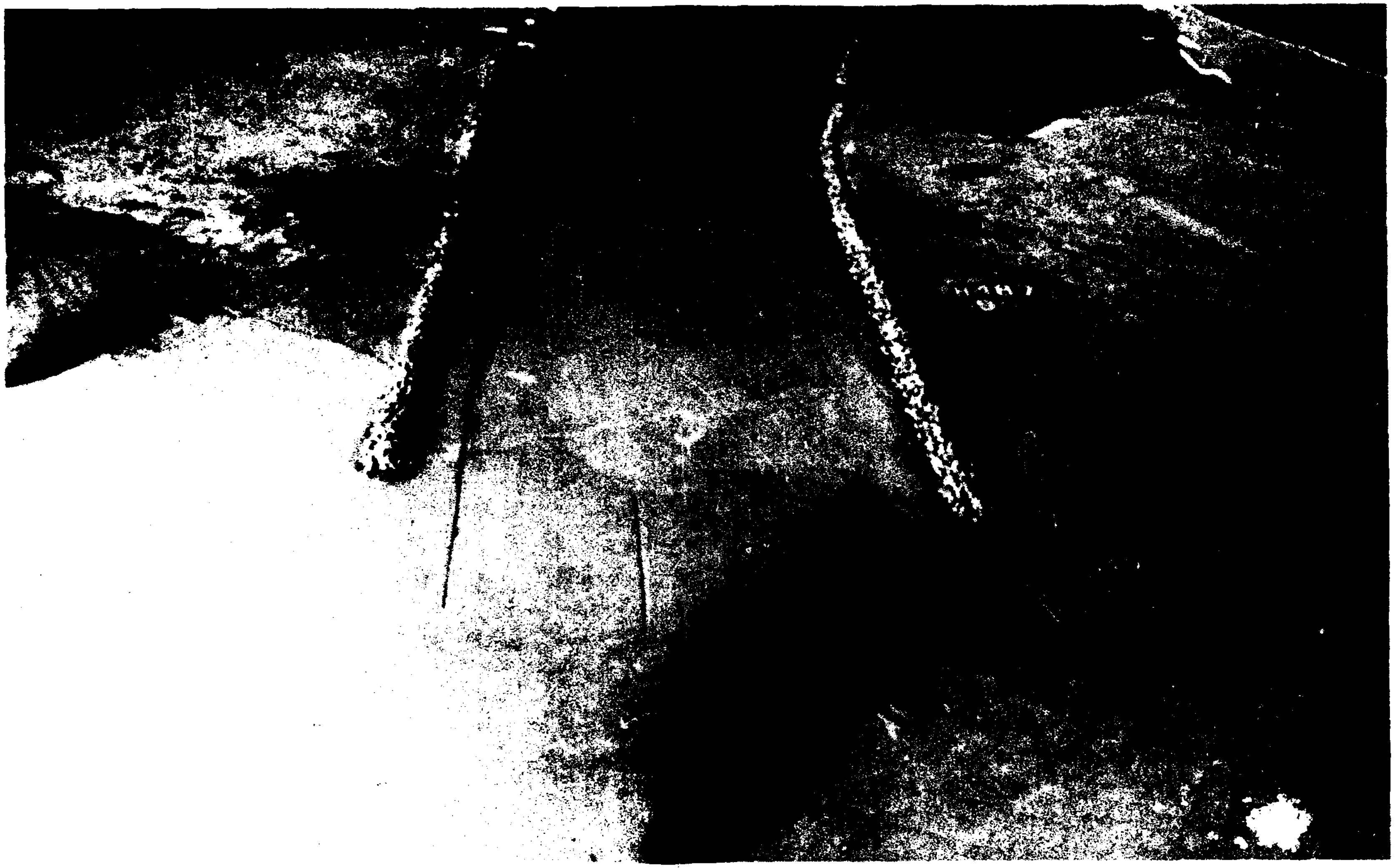


Photo 57. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west with Base Test 1 installed; swl = 0.0 ft

Photo 58. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for maximum ebb with Base Test 1 installed; swl = +1.5 ft

Photo 59. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum ebb with Base Test 1 installed; swl = +1.5 ft

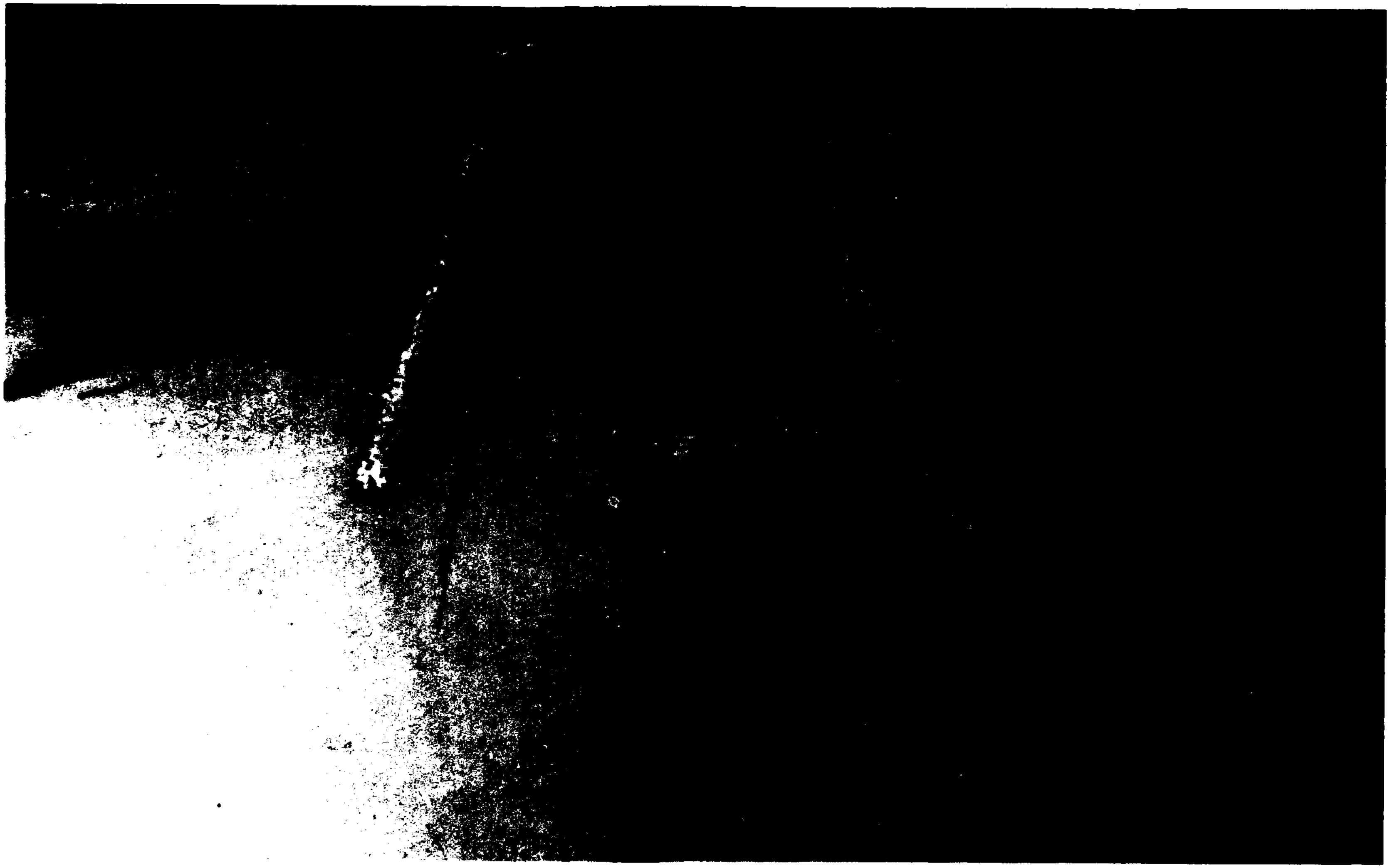


Photo 60. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for maximum ebb with Base Test 1 installed; swl = +1.5 ft

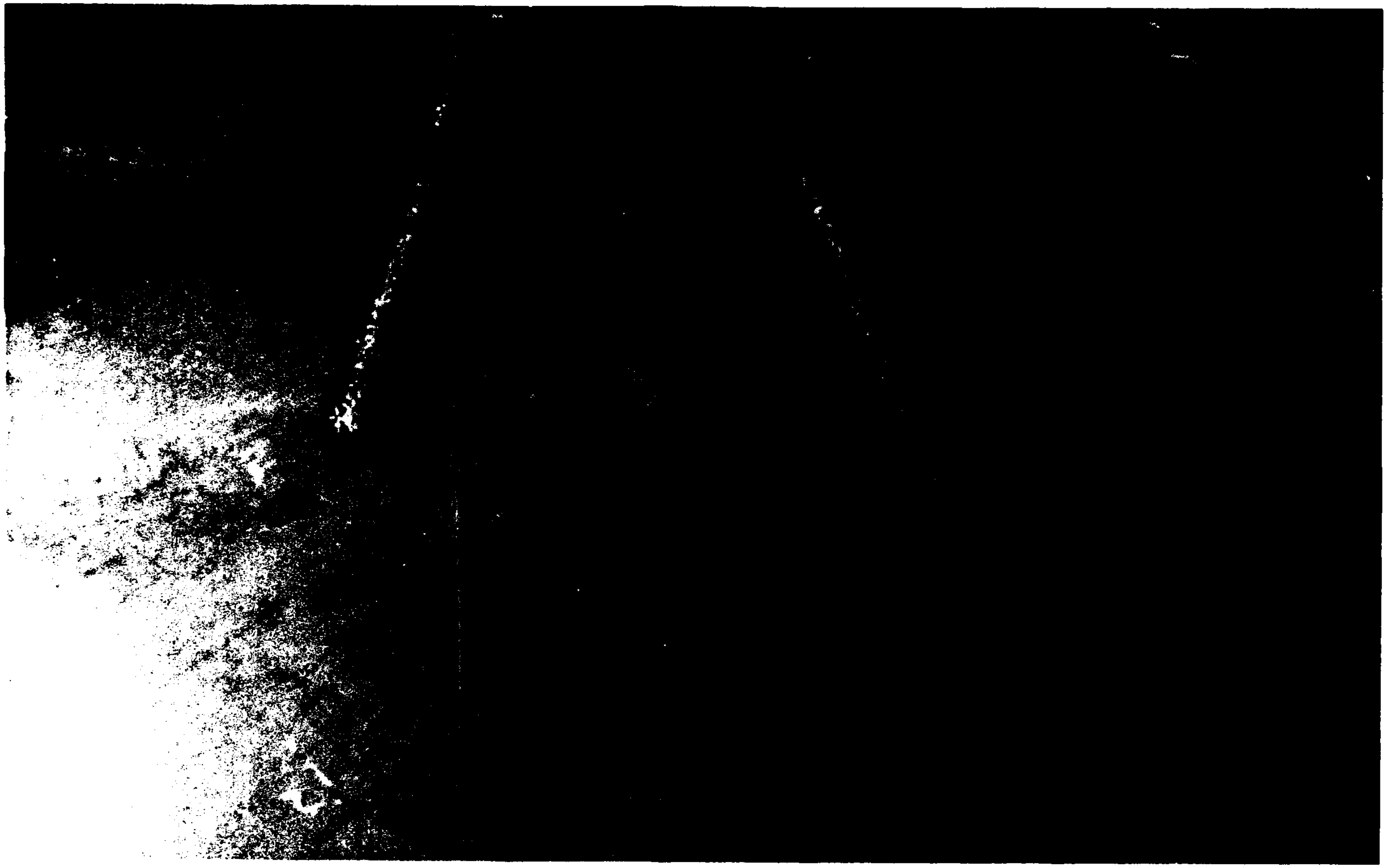


Photo 61. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for maximum flood with Base Test 1 installed; swl = +4.3 ft

Photo 62. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum flood with Base Test 1 installed; swl = +4.3 ft

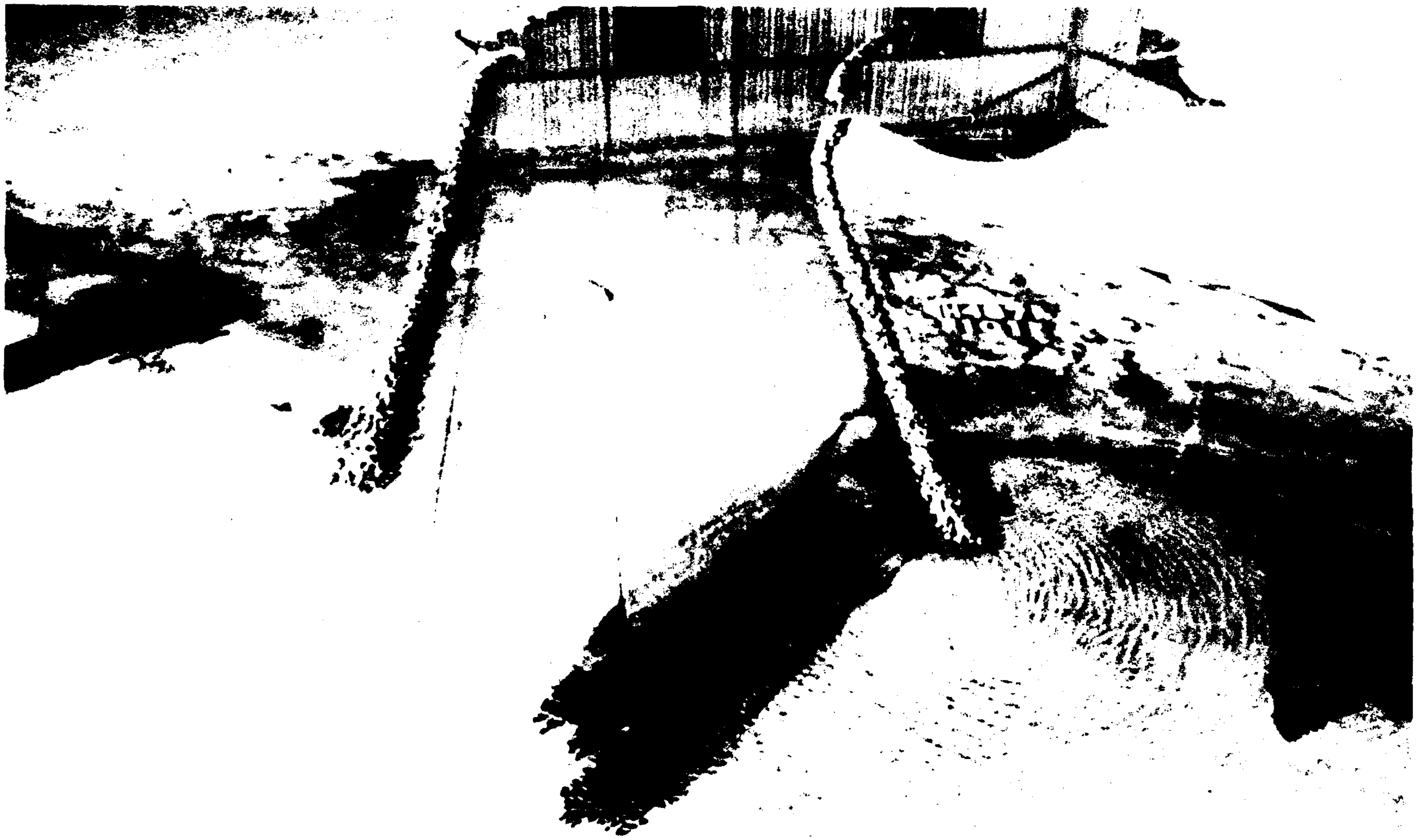


Photo 63. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for maximum flood with Base Test 1 installed; swl = +4.3 ft

Photo 64. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west with Base Test 1 installed; swl = +6.7 ft

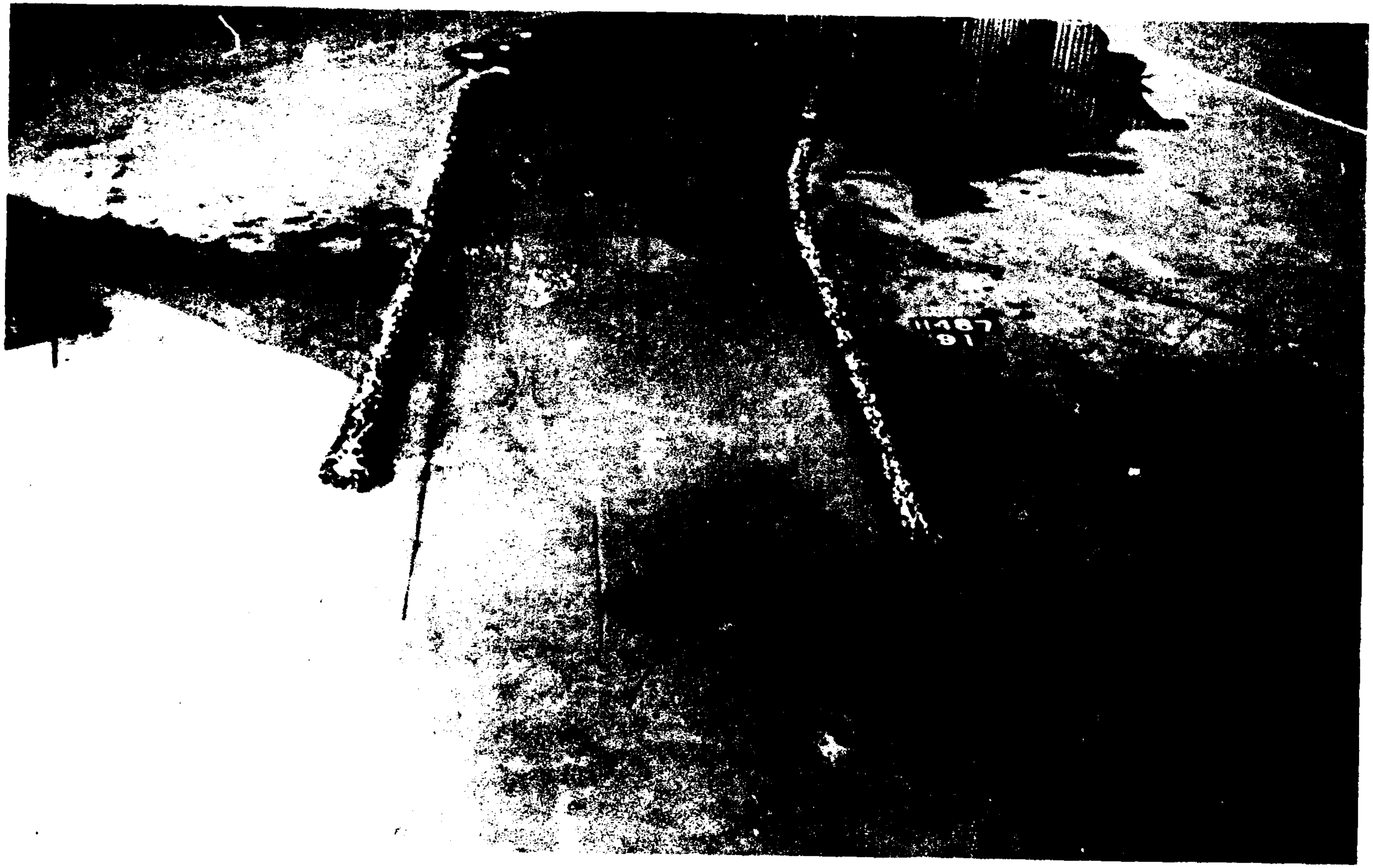


Photo 65. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west with Base Test 1 installed; swl = +6.7 ft

Photo 66. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west with Base Test 1 installed; swl = +6.7 ft

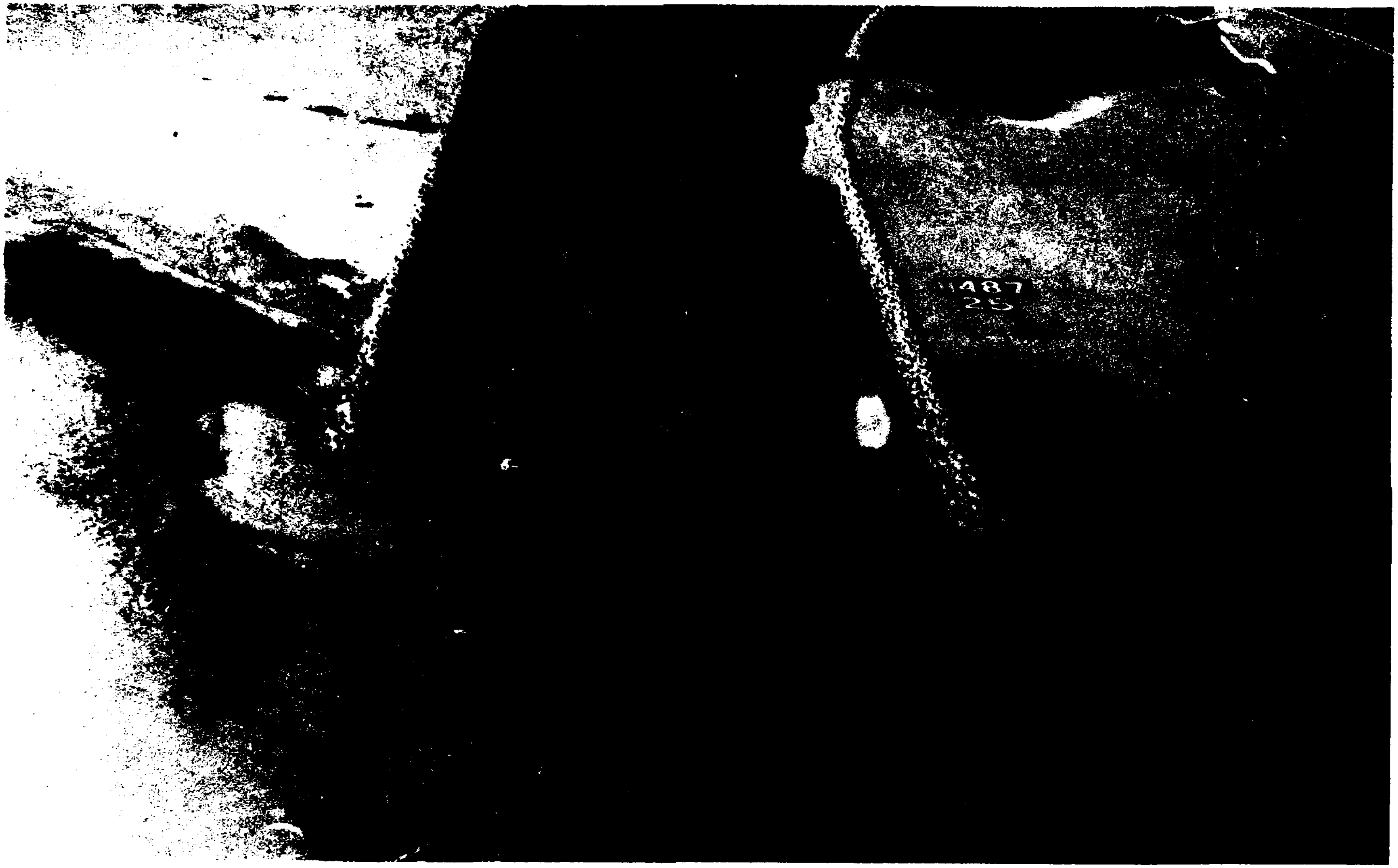


Photo 67. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW with Base Test 1 installed; swl = 0.0 ft

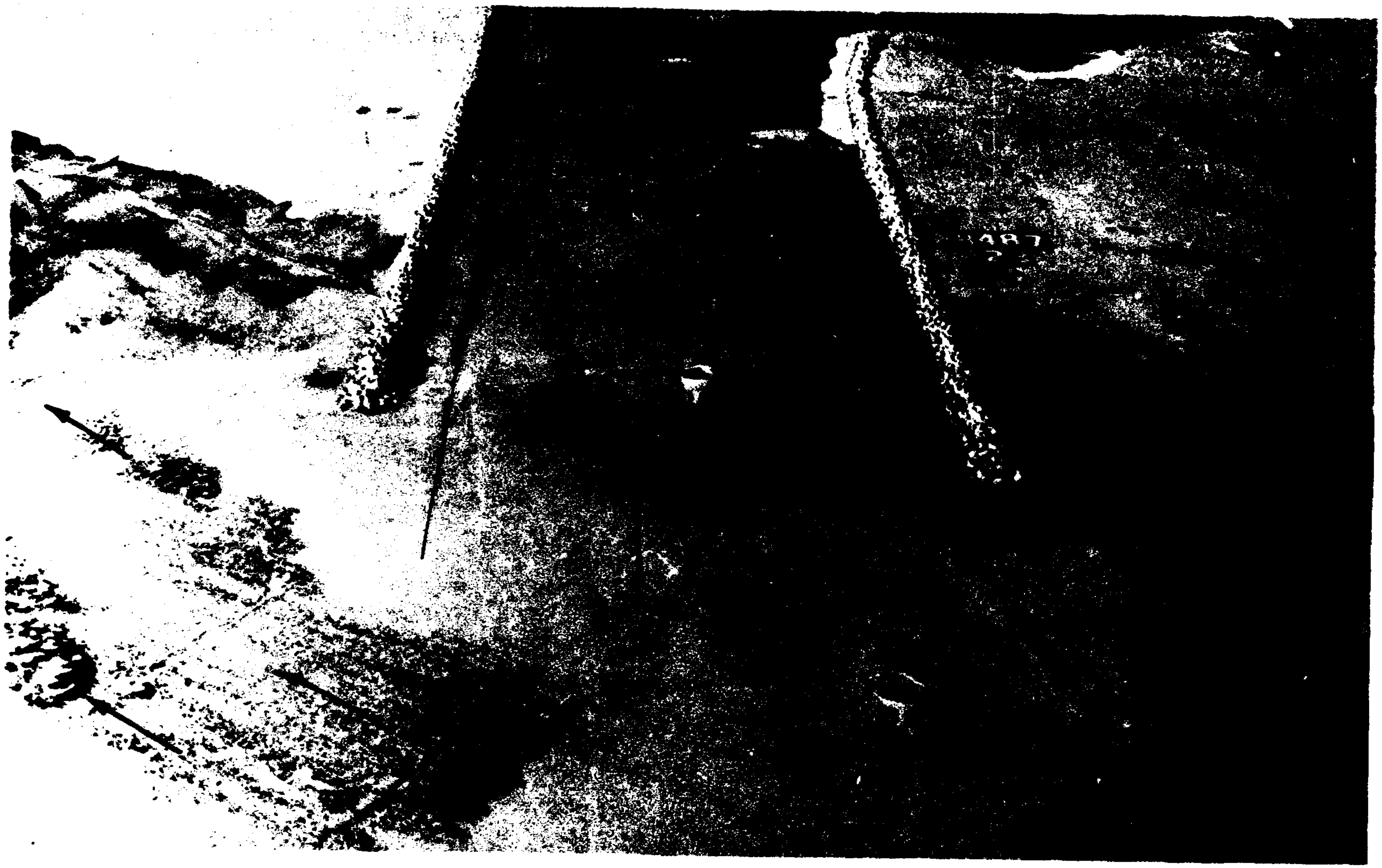


Photo 68. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW with Base Test 1 installed; swl = 0.0 ft

Photo 69. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW with Base Test 1 installed; swl = 0.0 ft

Photo 70. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

Photo 71. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

Photo 72. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

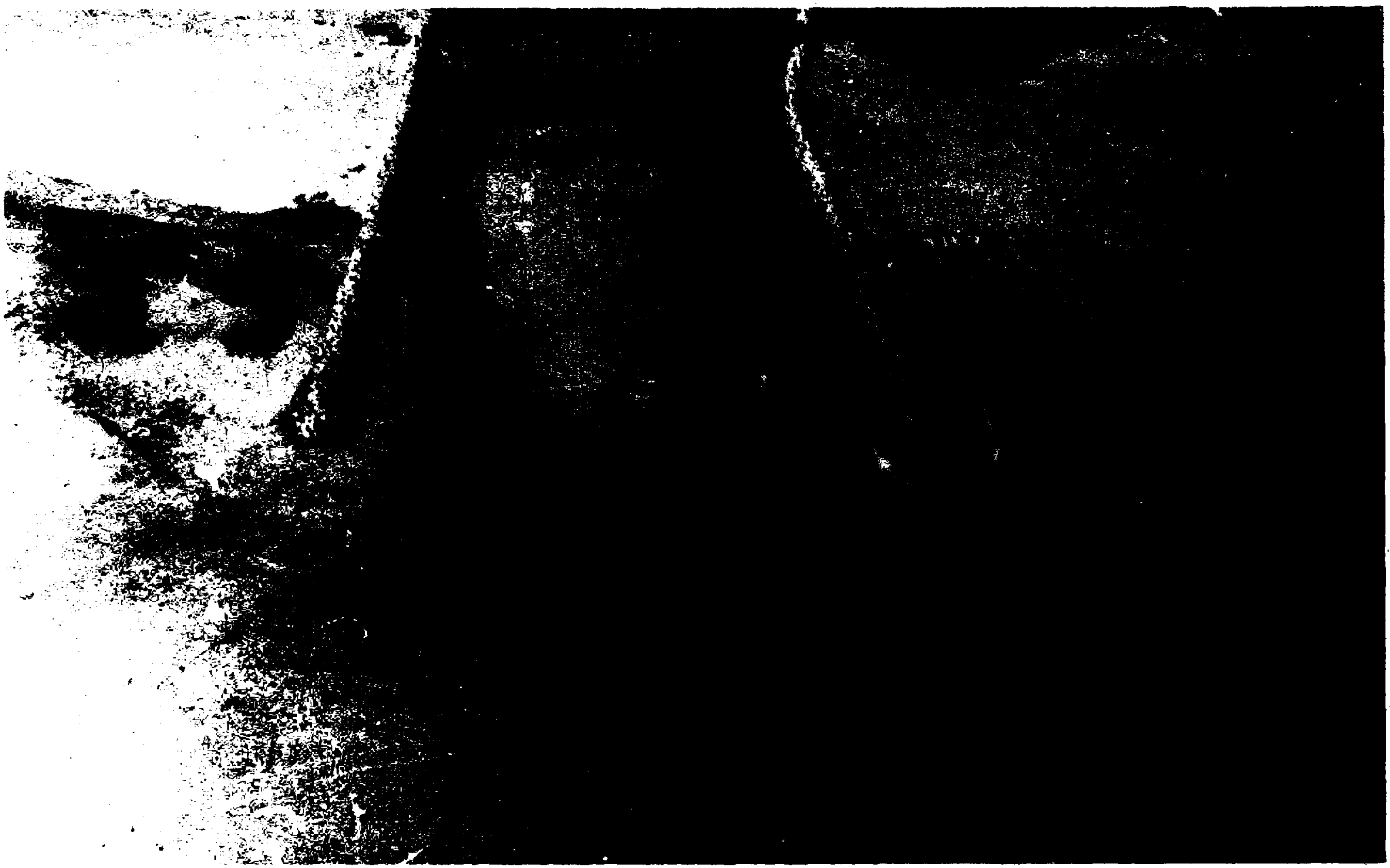


Photo 73. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for maximum flood with Base Test 1 installed; swl = +4.3 ft

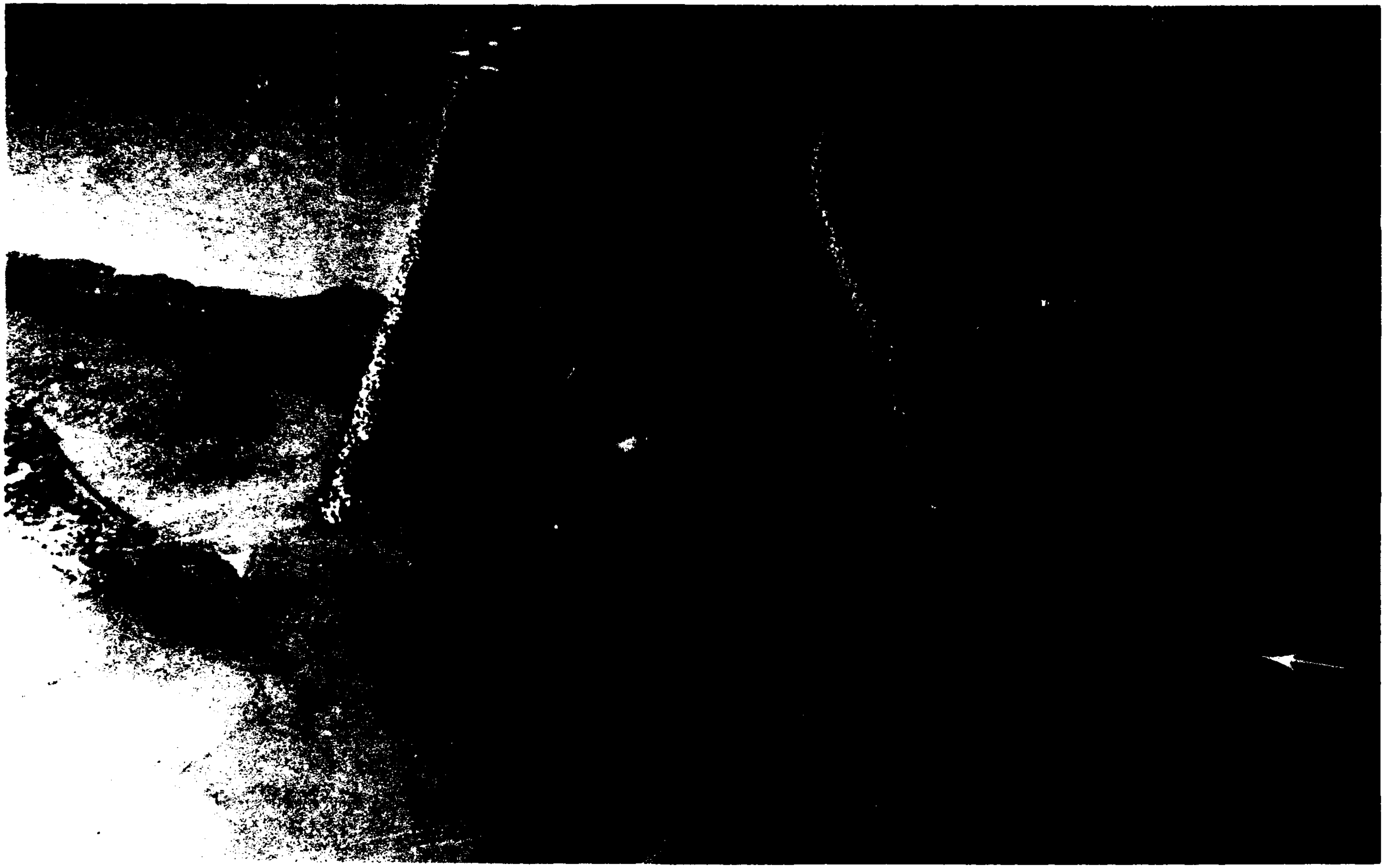


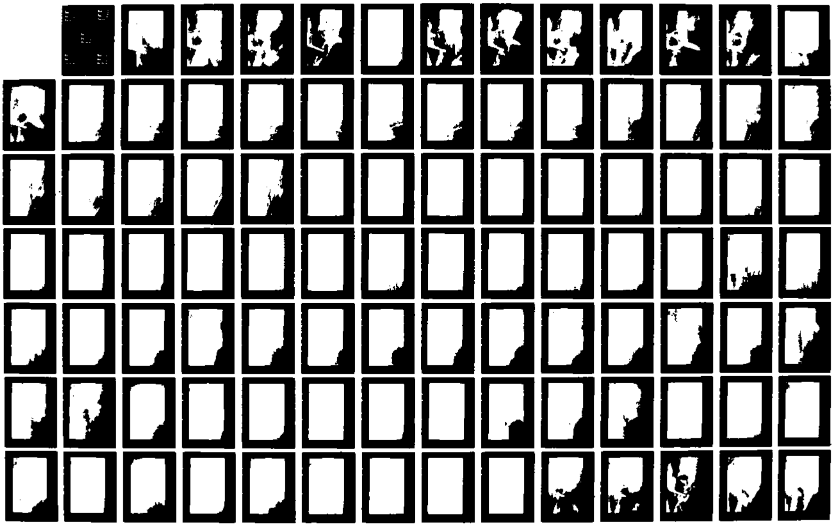
Photo 74. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW; for maximum flood with Base Test 1 installed; swl = +4.3 ft

Photo 75. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for maximum flood with Base Test 1 installed; swl = +4.3 ft

Photo 76. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW with Base Test 1 installed; swl = +6.7 ft

Photo 77. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW with Base Test 1 installed; swl = +6.7 ft

AD-A120 826 DESIGN FOR FLOOD CONTROL WAVE PROTECTION AND PREVENTION 3/7
OF SHOALING ROGUE..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
UNCLASSIFIED AUG 82 WES/TR/HL-82-18 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Photo 78. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW with Base Test 1 installed; swl = +6.7 ft

Photo 79. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW with Base Test 1 installed; swl = 0.0 ft

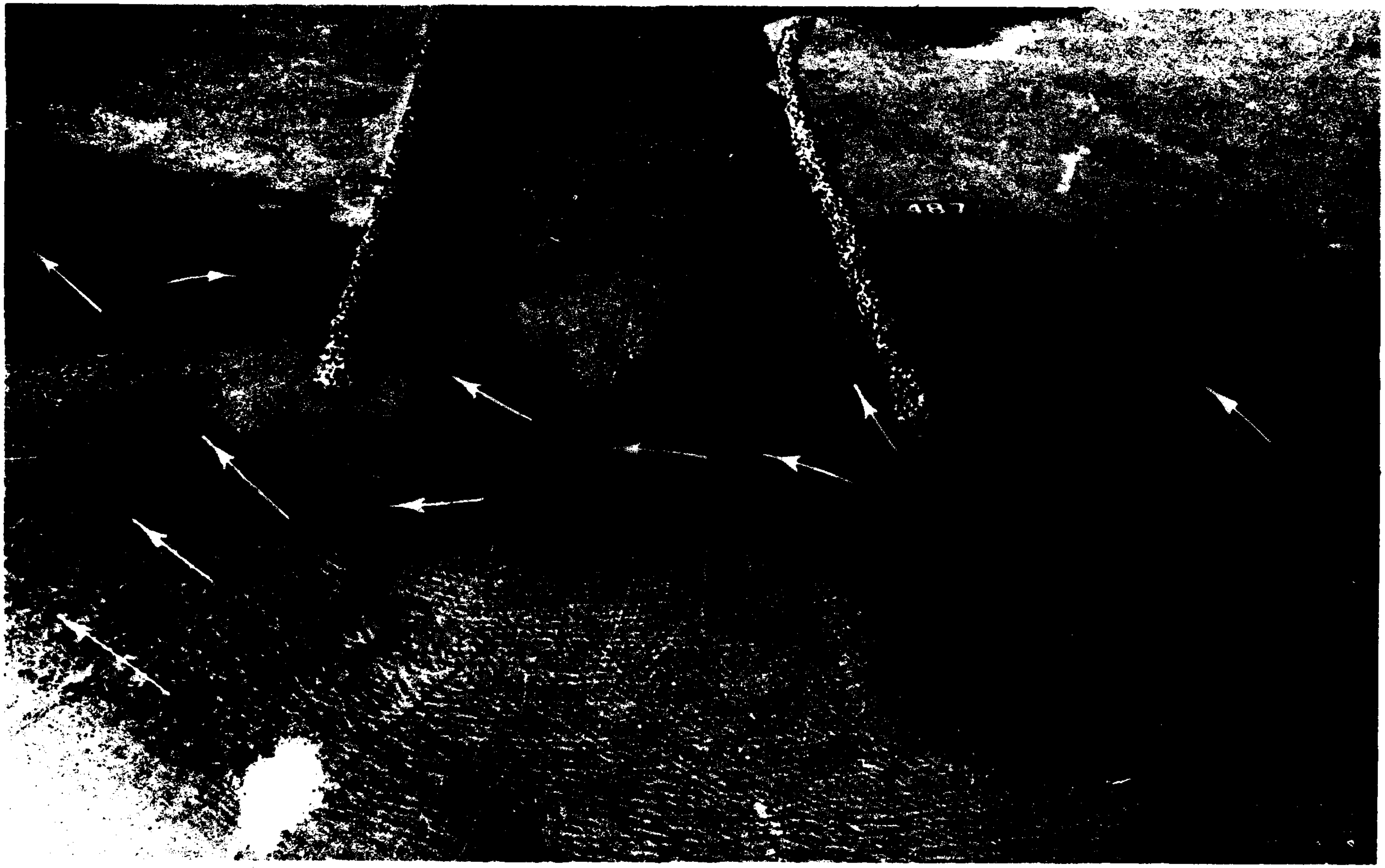


Photo 80. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW with Base Test 1 installed; swl = 0.0 ft

Photo 81. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW with Base Test 1 installed; swl = 0.0 ft

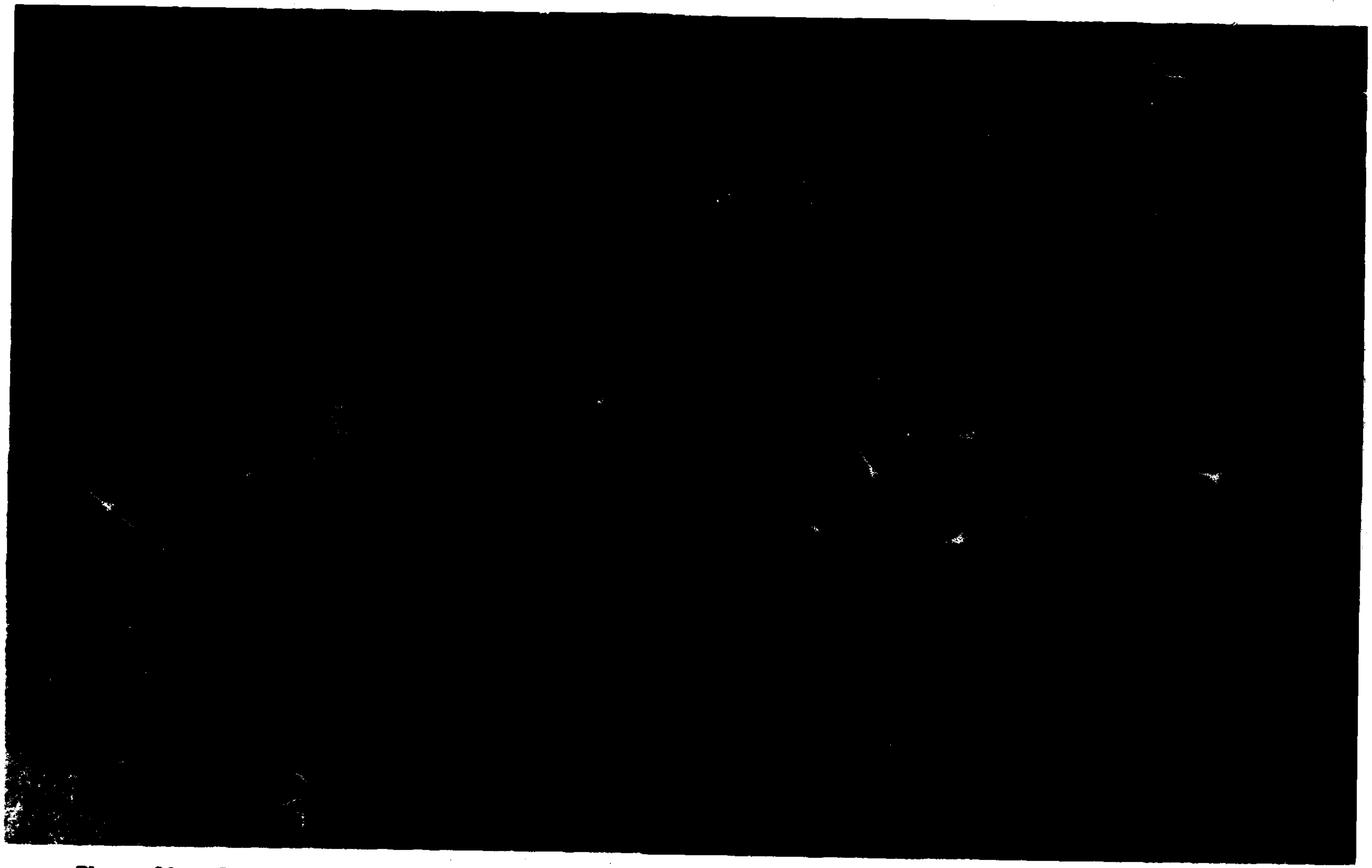


Photo 82. General movement of tracer materials and deposits resulting from 9-sec, 27-ft waves from SSW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

Photo 83. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

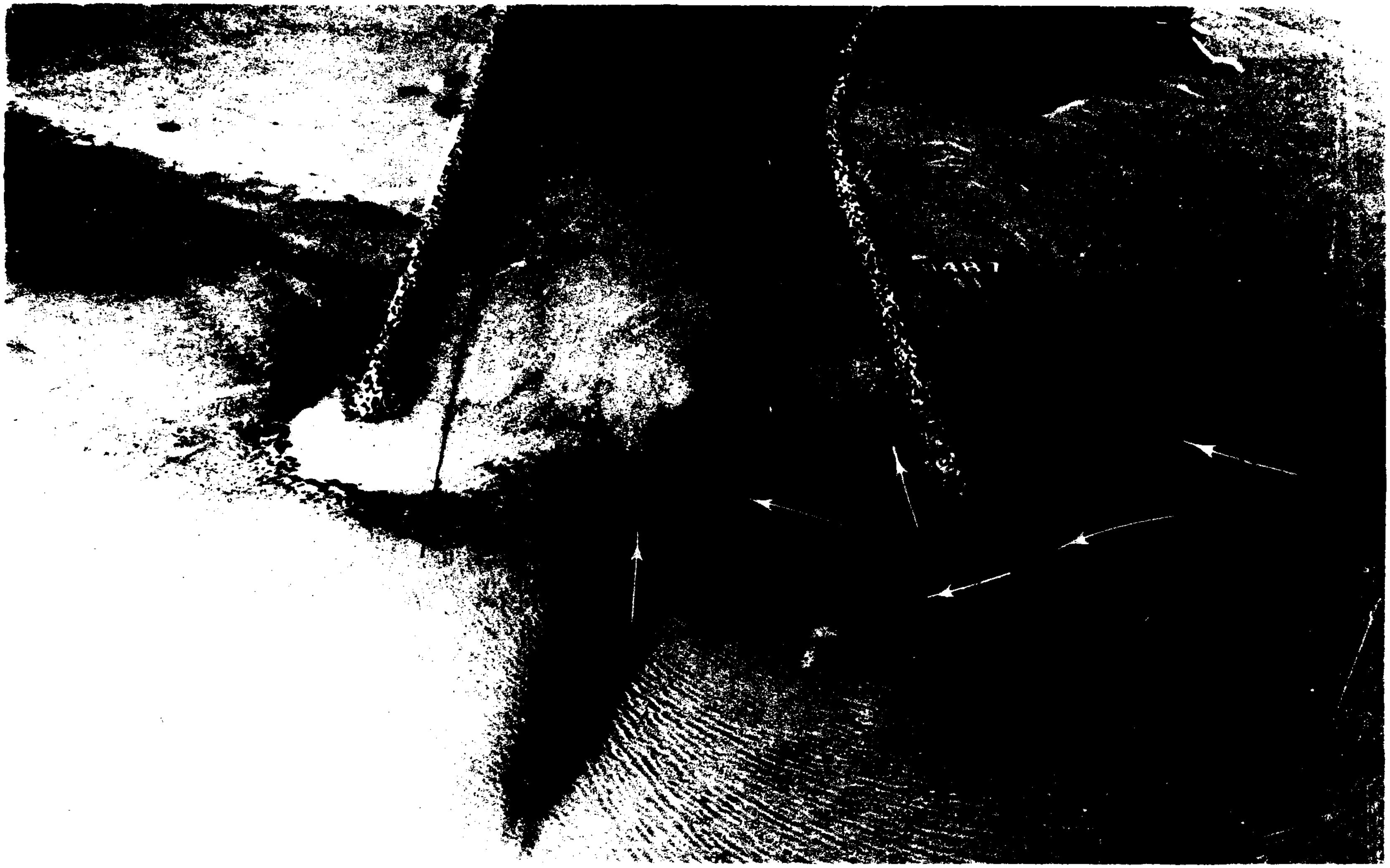


Photo 84. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for maximum ebb with Base Test 1 installed; swl = +1.5 ft

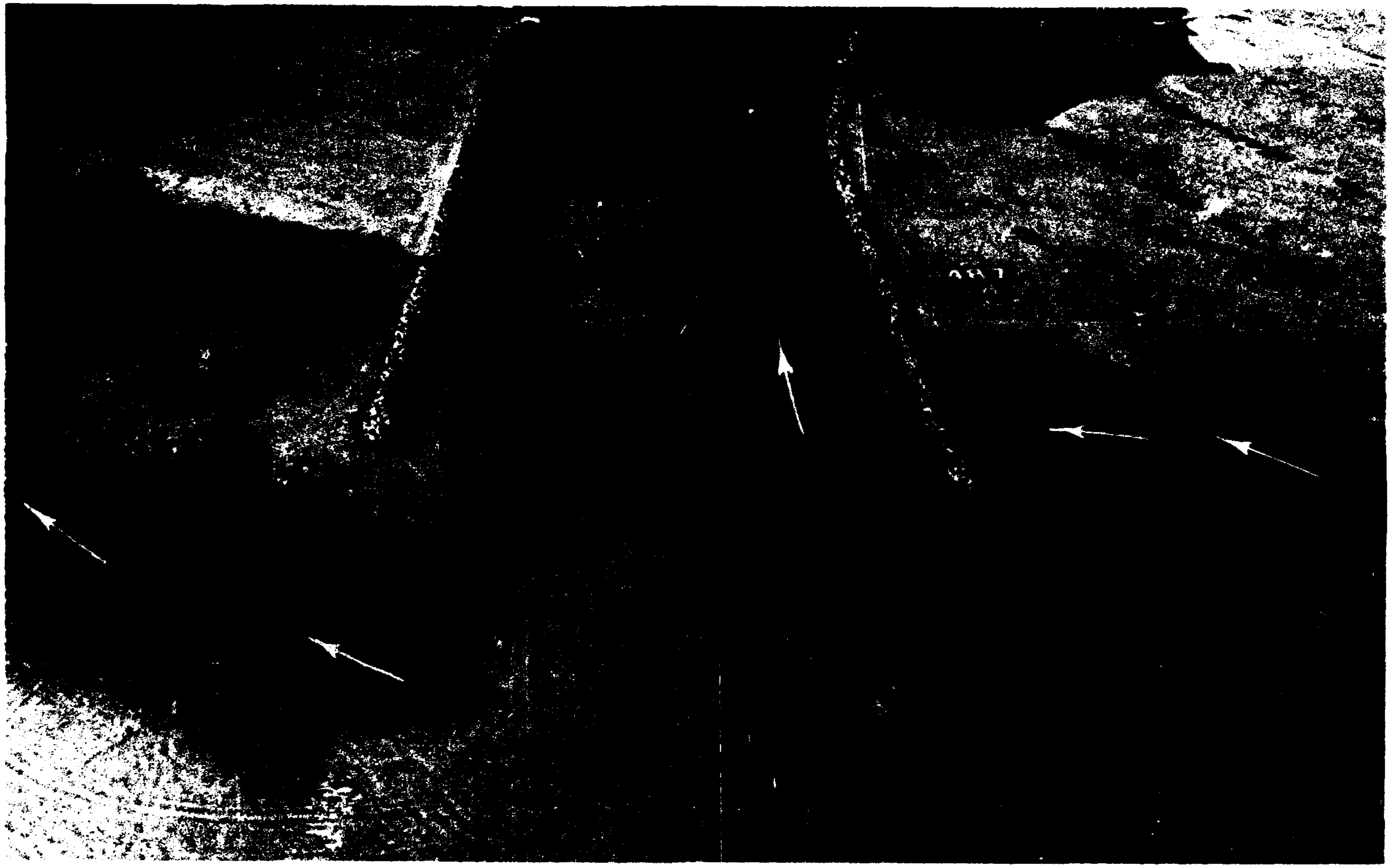


Photo 85. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for maximum flood with Base Test 1 installed; swl = +4.3 ft

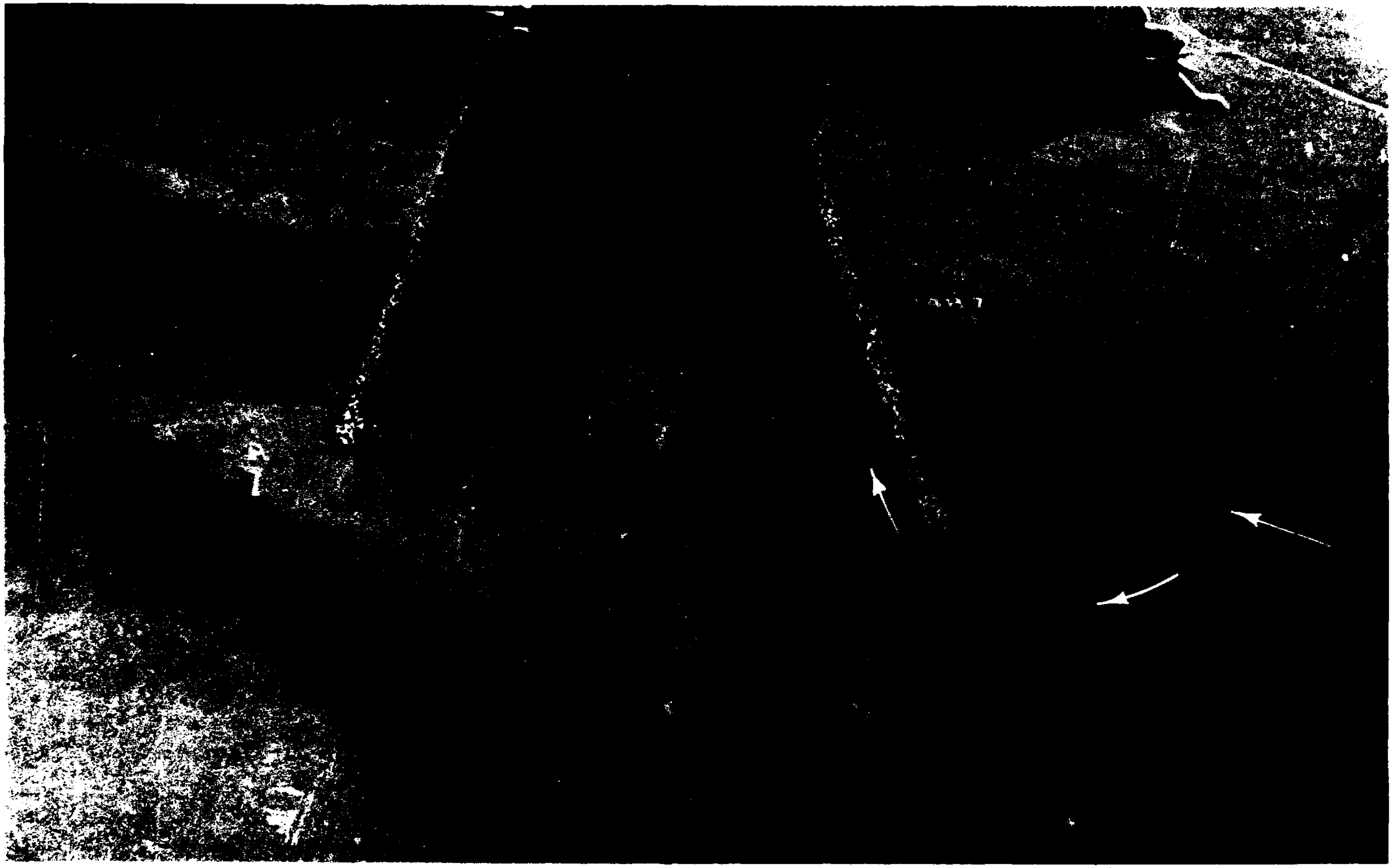


Photo 86. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum flood with Base Test 1 installed; swl = +4.3 ft

Photo 87. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for maximum flood with Base Test 1 installed; swl = +4.3 ft

Photo 88. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW with Base Test 1 installed; swl = +6.7 ft

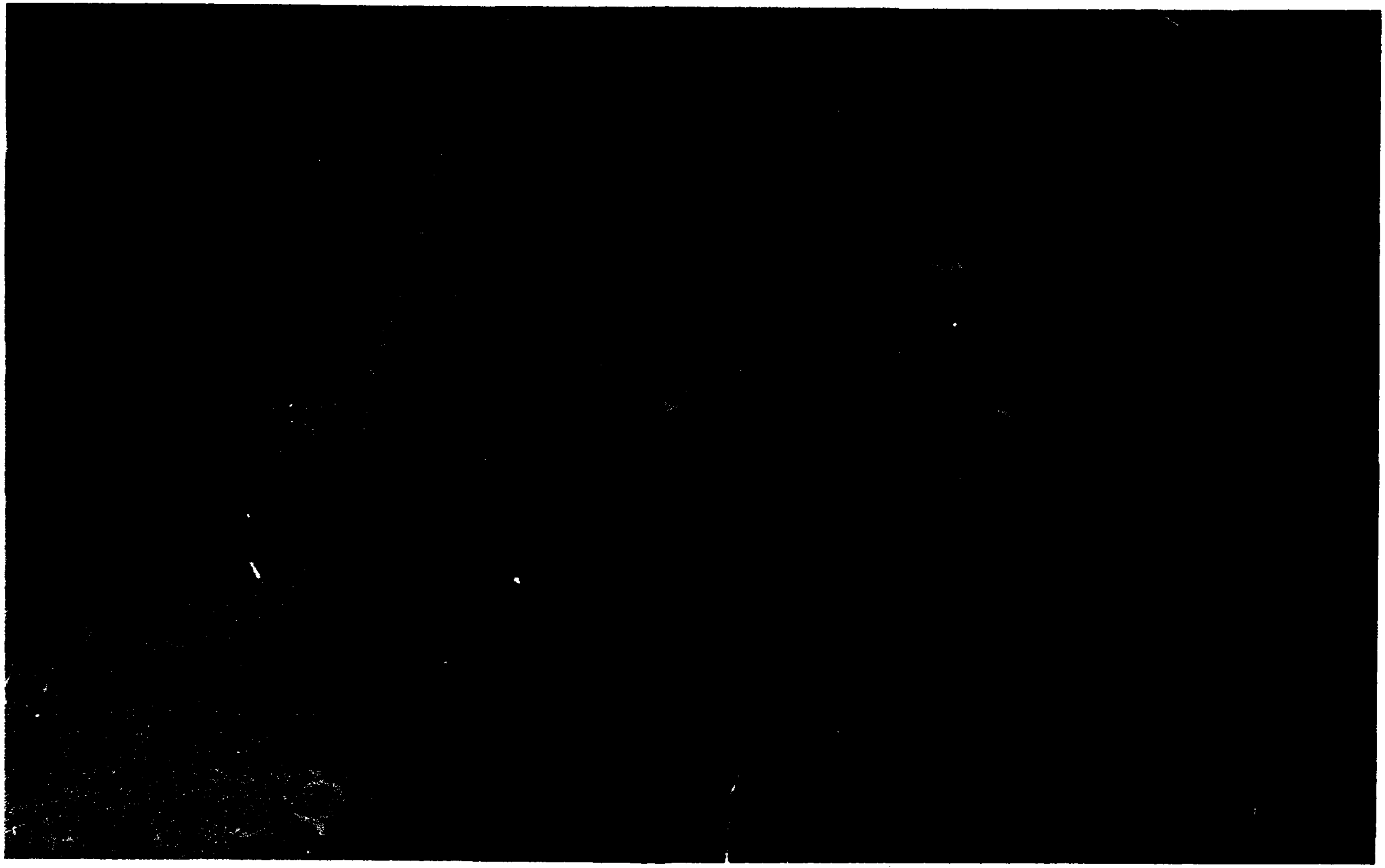


Photo 89. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW with Base Test 1 installed; swl = +6.7 ft

Photo 90. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW with Base Test 1 installed; swl = +6.7 ft

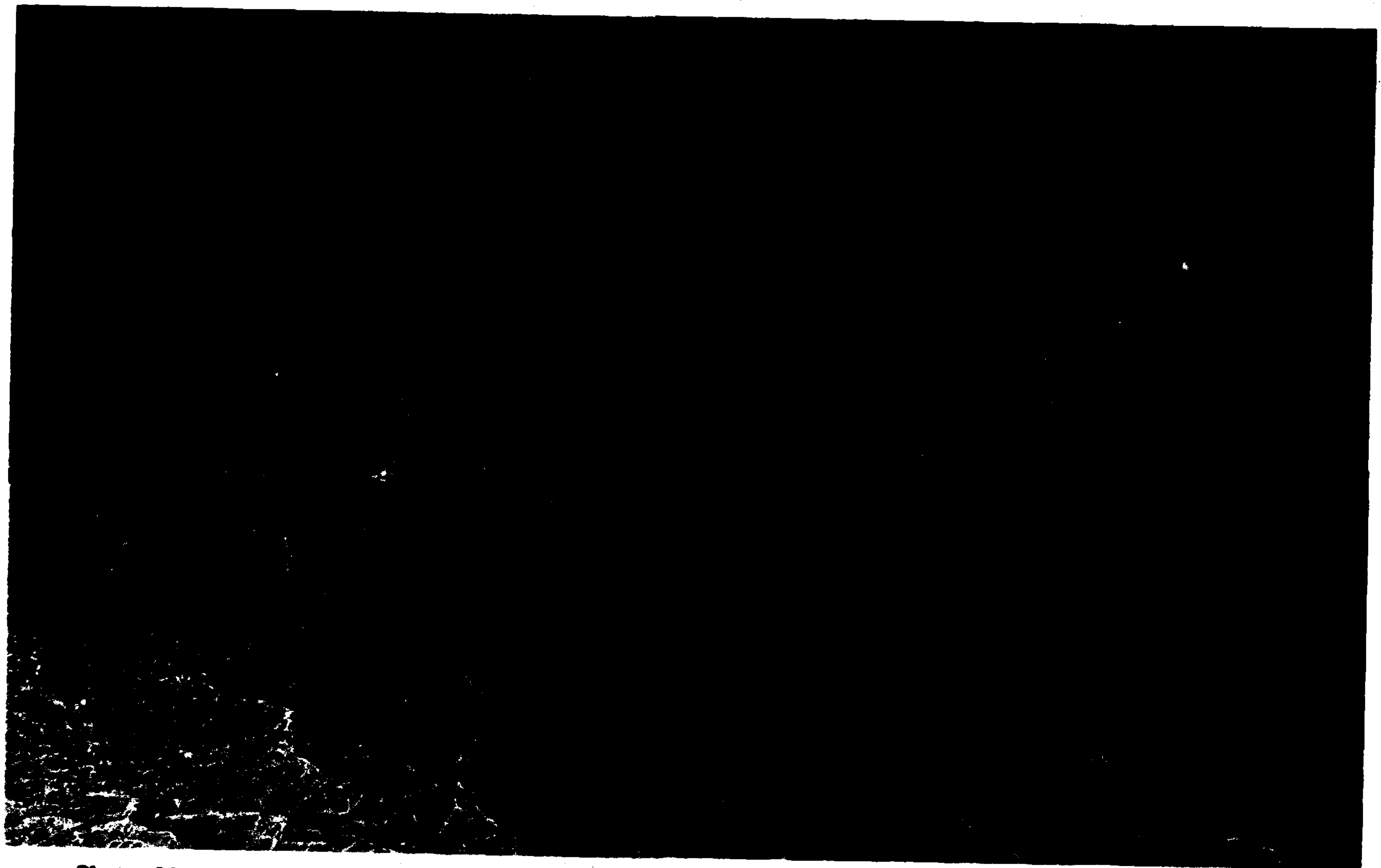


Photo 91. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 27-ft waves from NNW for maximum ebb; swl = +1.5 ft

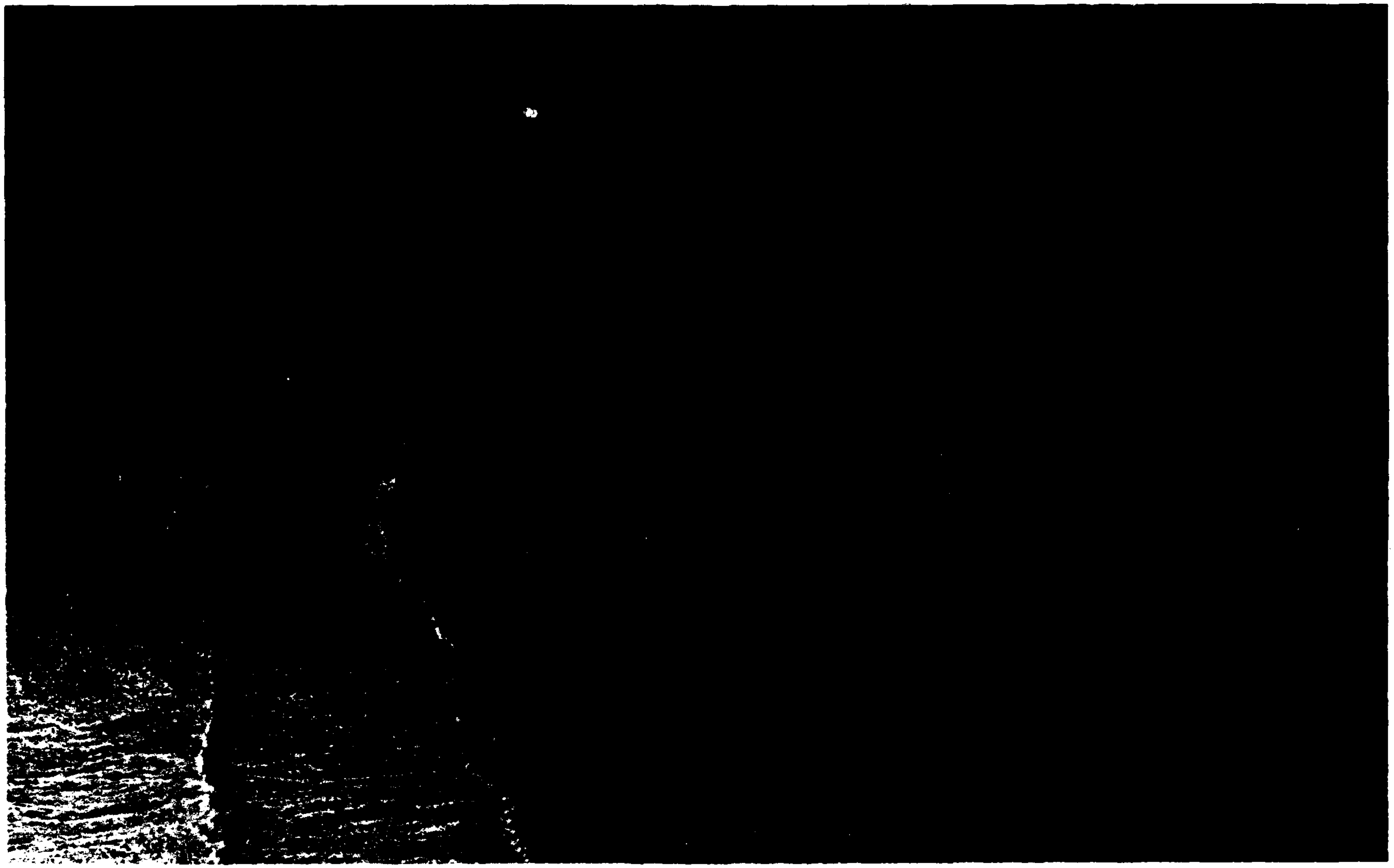


Photo 92. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from NNW for maximum ebb; swl = +1.5 ft

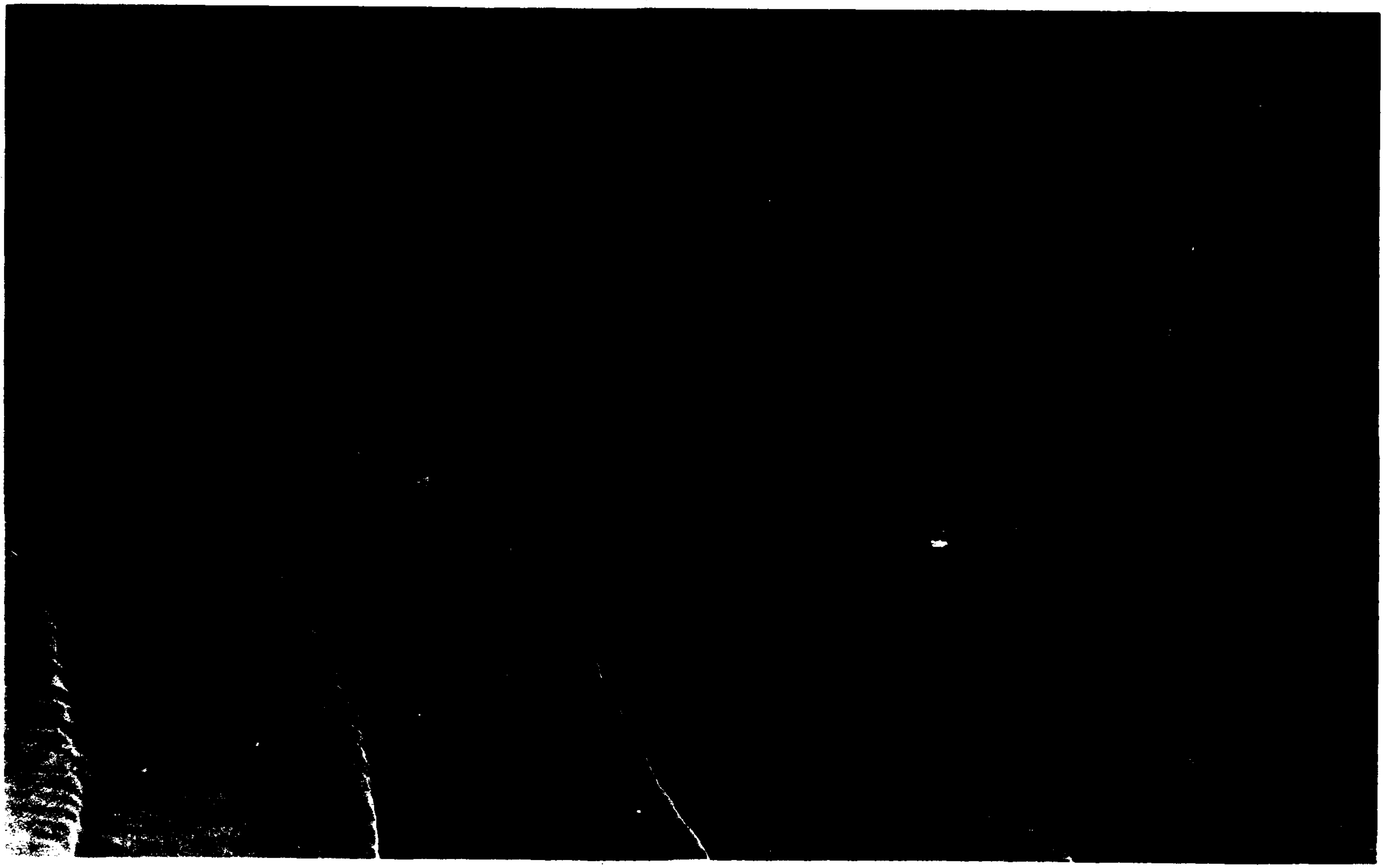


Photo 93. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from NNW for maximum ebb; swl = +1.5 ft

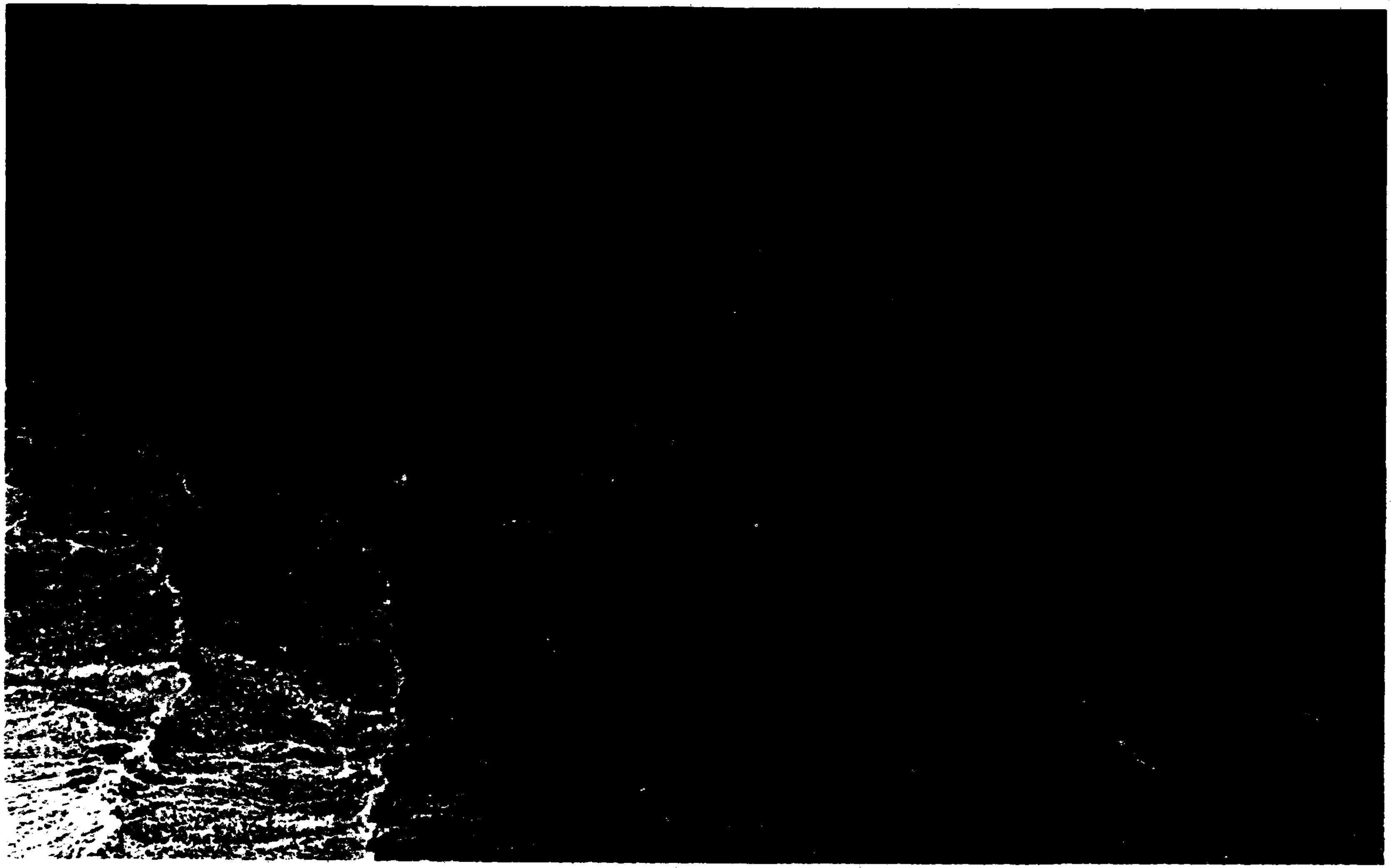


Photo 94. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 27-ft waves from NNW for maximum flood; swl = +4.3 ft

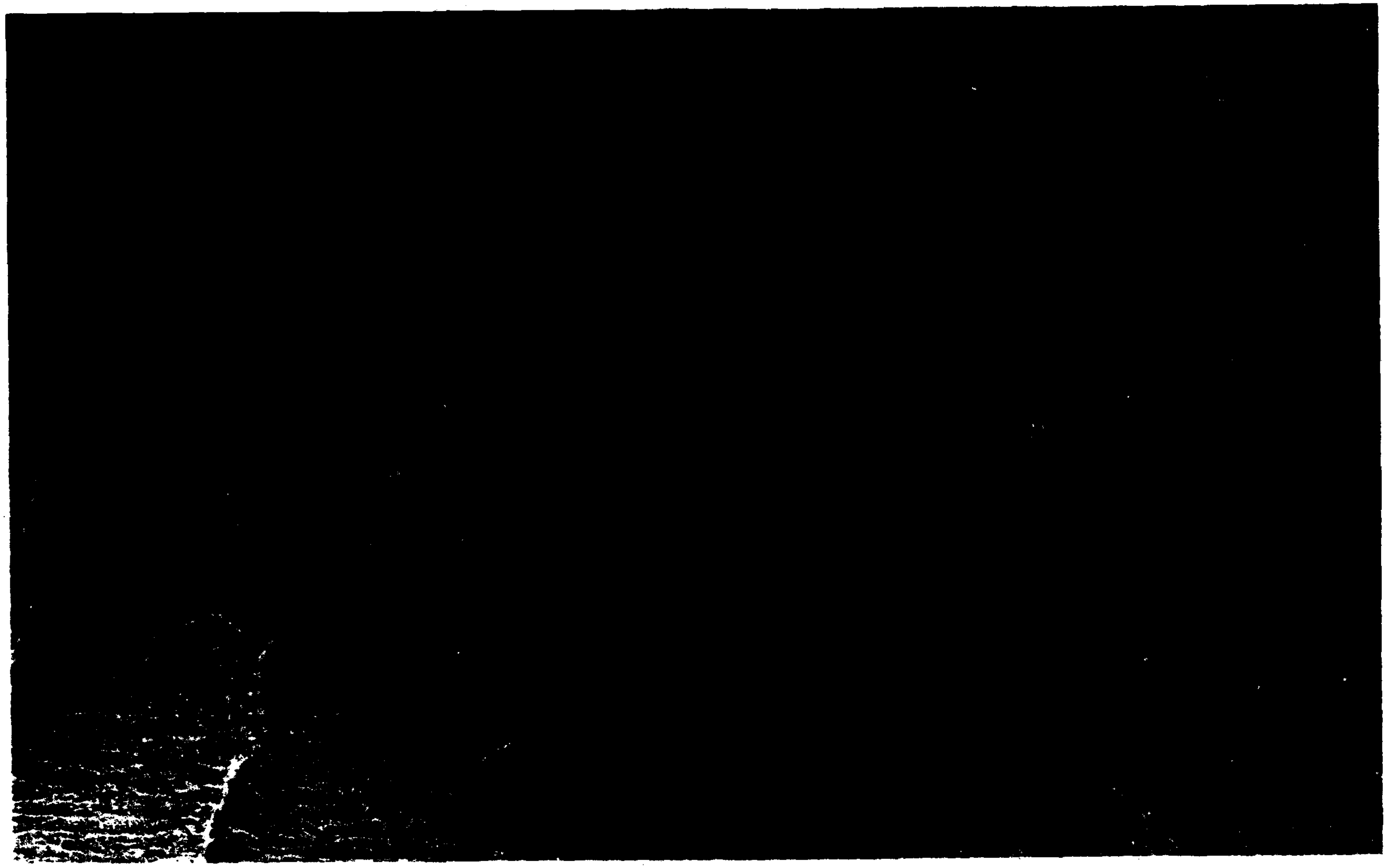


Photo 95. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from NNW for maximum flood; swl = +4.3 ft

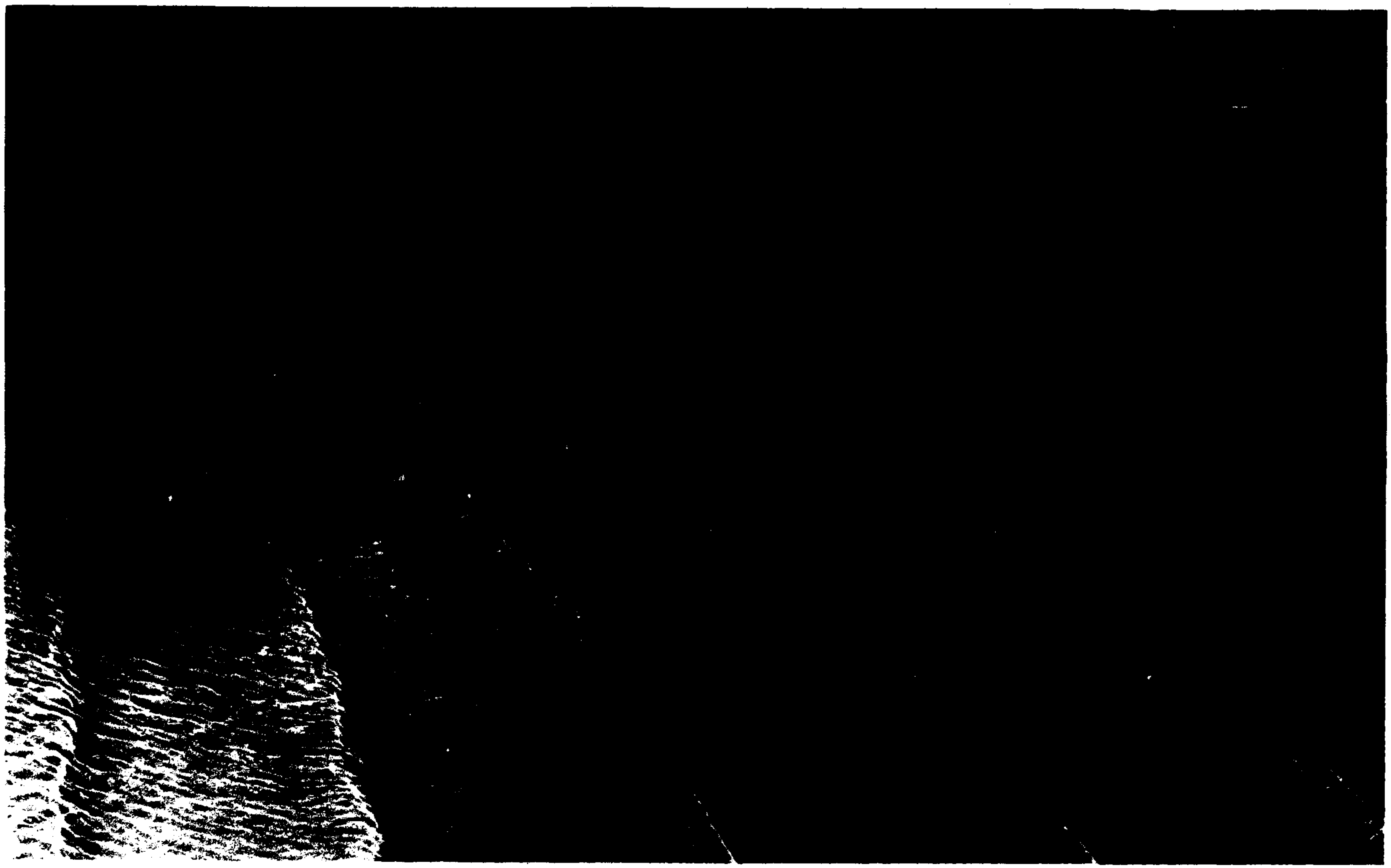


Photo 96. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from NNW for maximum flood; swl = +4.3 ft

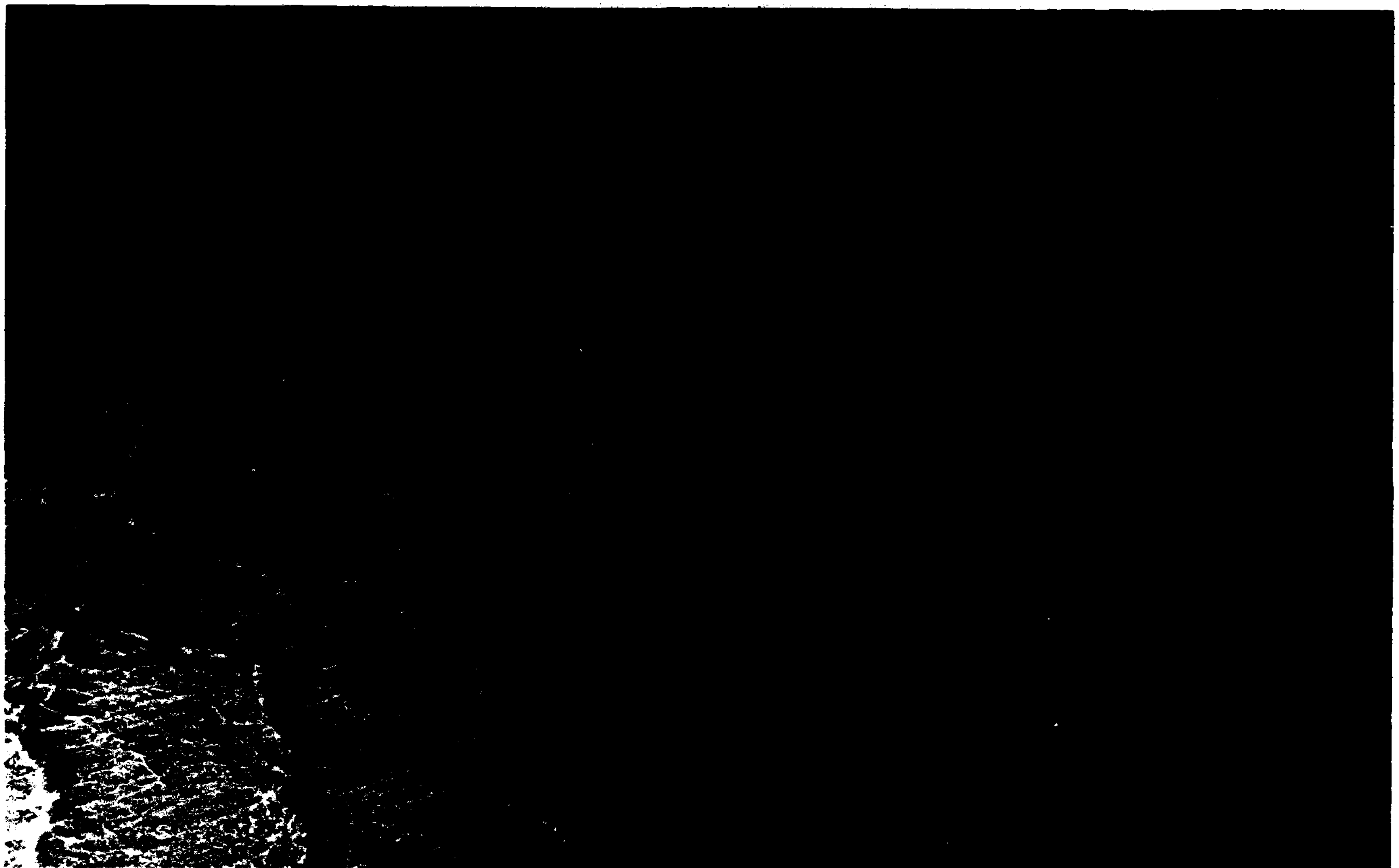


Photo 97. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 27-ft waves from NNW; swl = +6.7 ft

Photo 98. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from NNW; swl = +6.7 ft

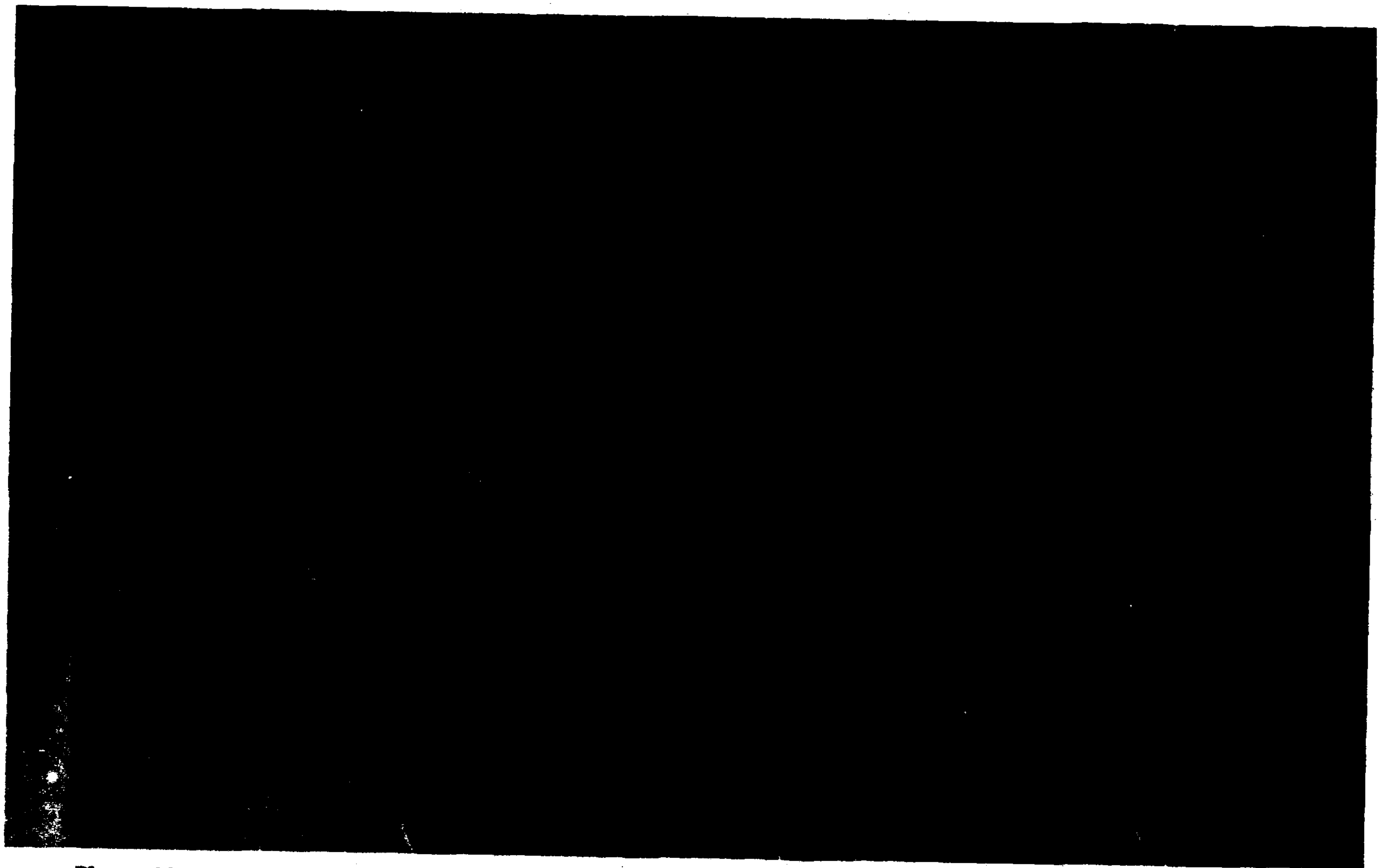


Photo 99. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from NNW; swl = +6.7 ft

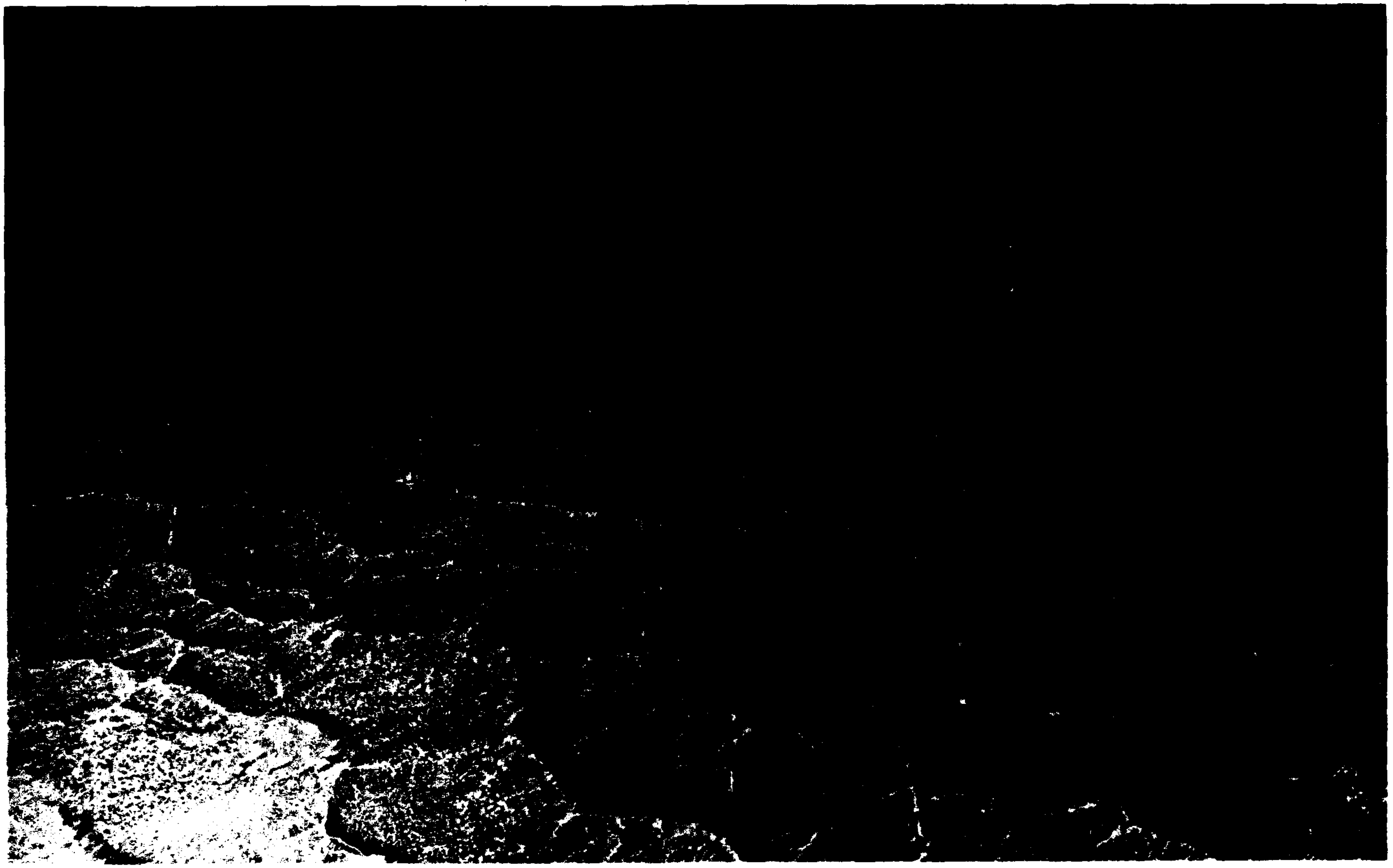


Photo 100. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 23-ft waves from west for maximum ebb; swl = +1.5 ft

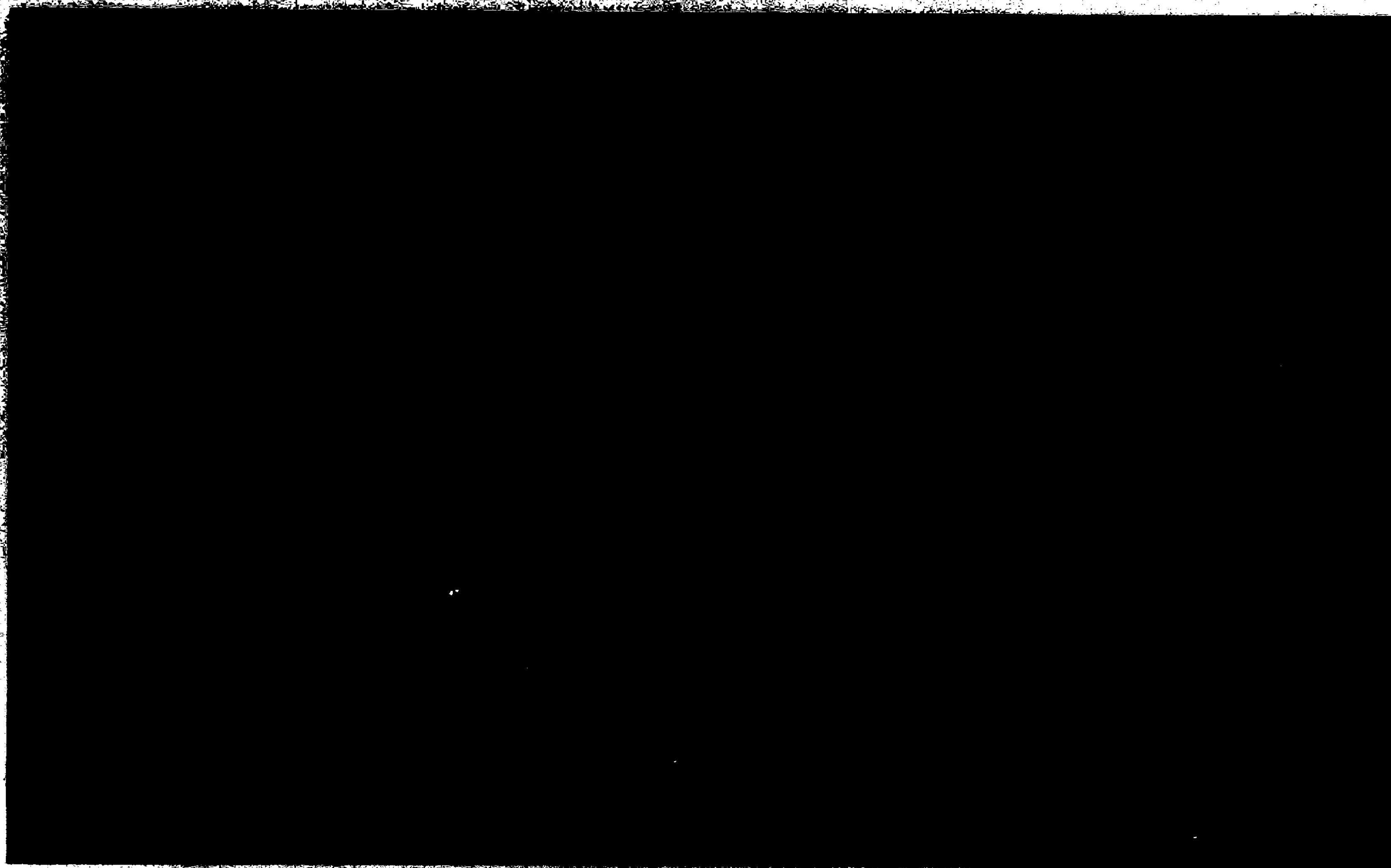


Photo 108. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from west for maximum ebb; swl = +1.5 ft

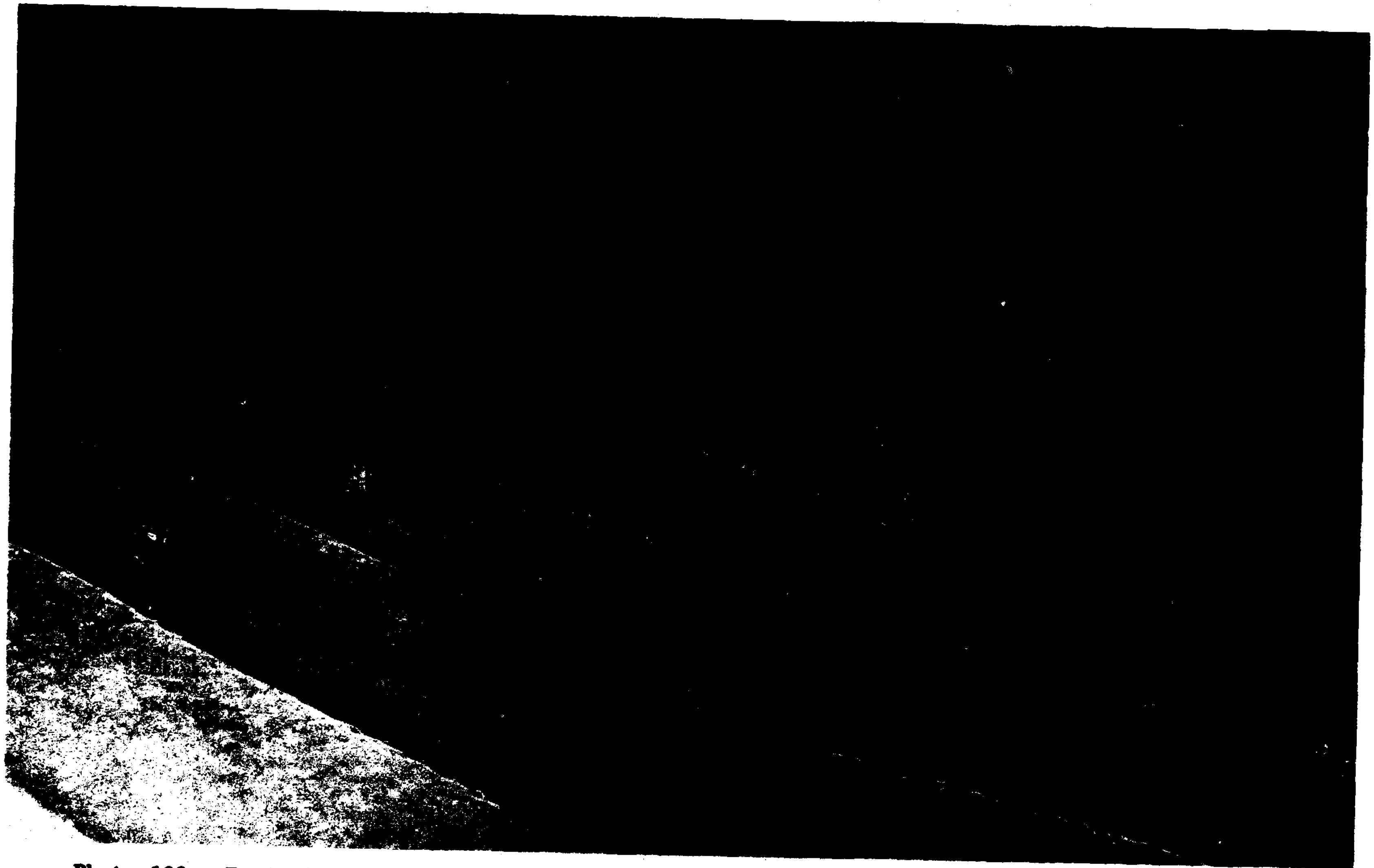


Photo 102. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from west for maximum ebb; swl = +1.5 ft

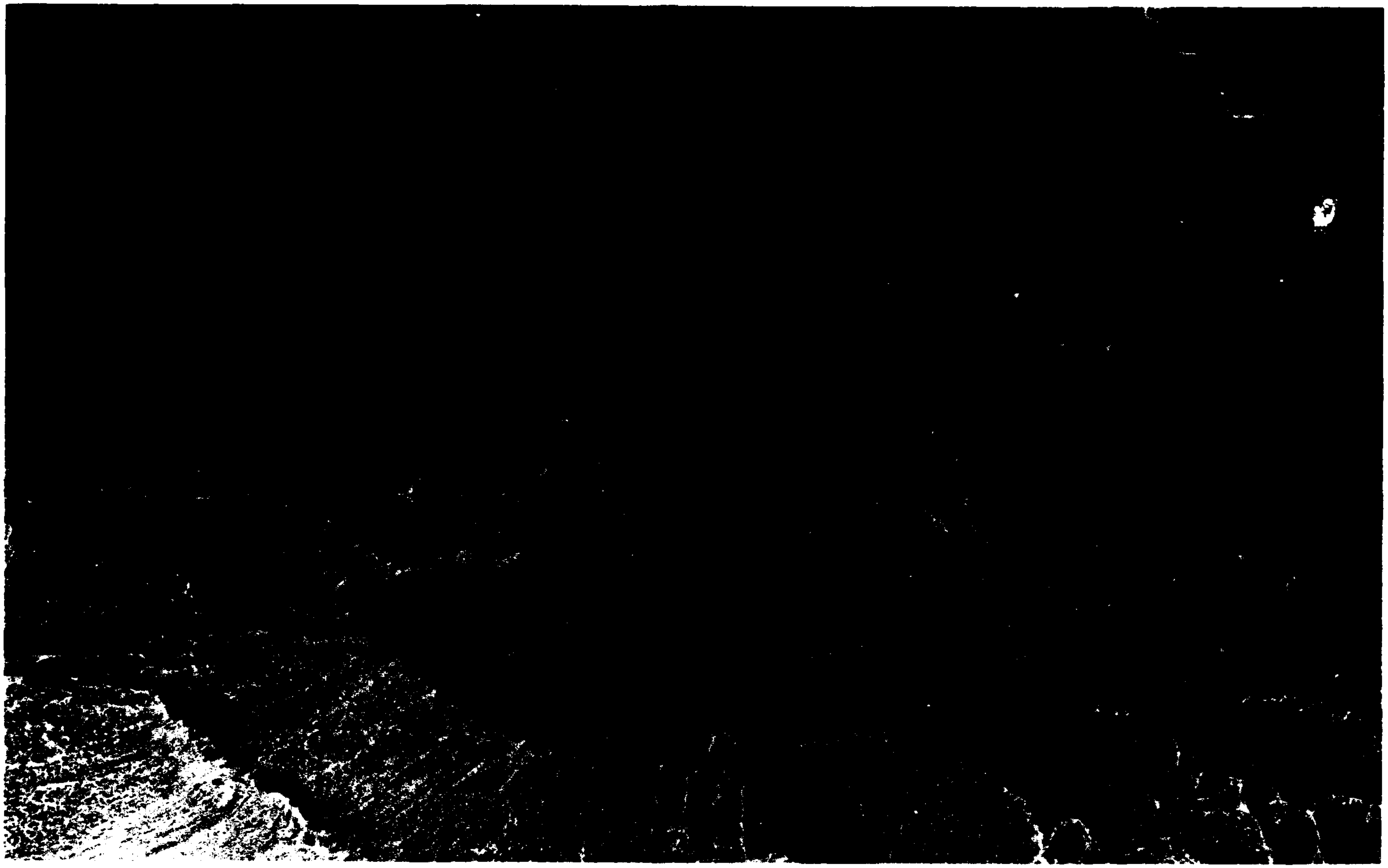


Photo 103. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 23-ft waves from west for maximum flood; swl = +4.3 ft

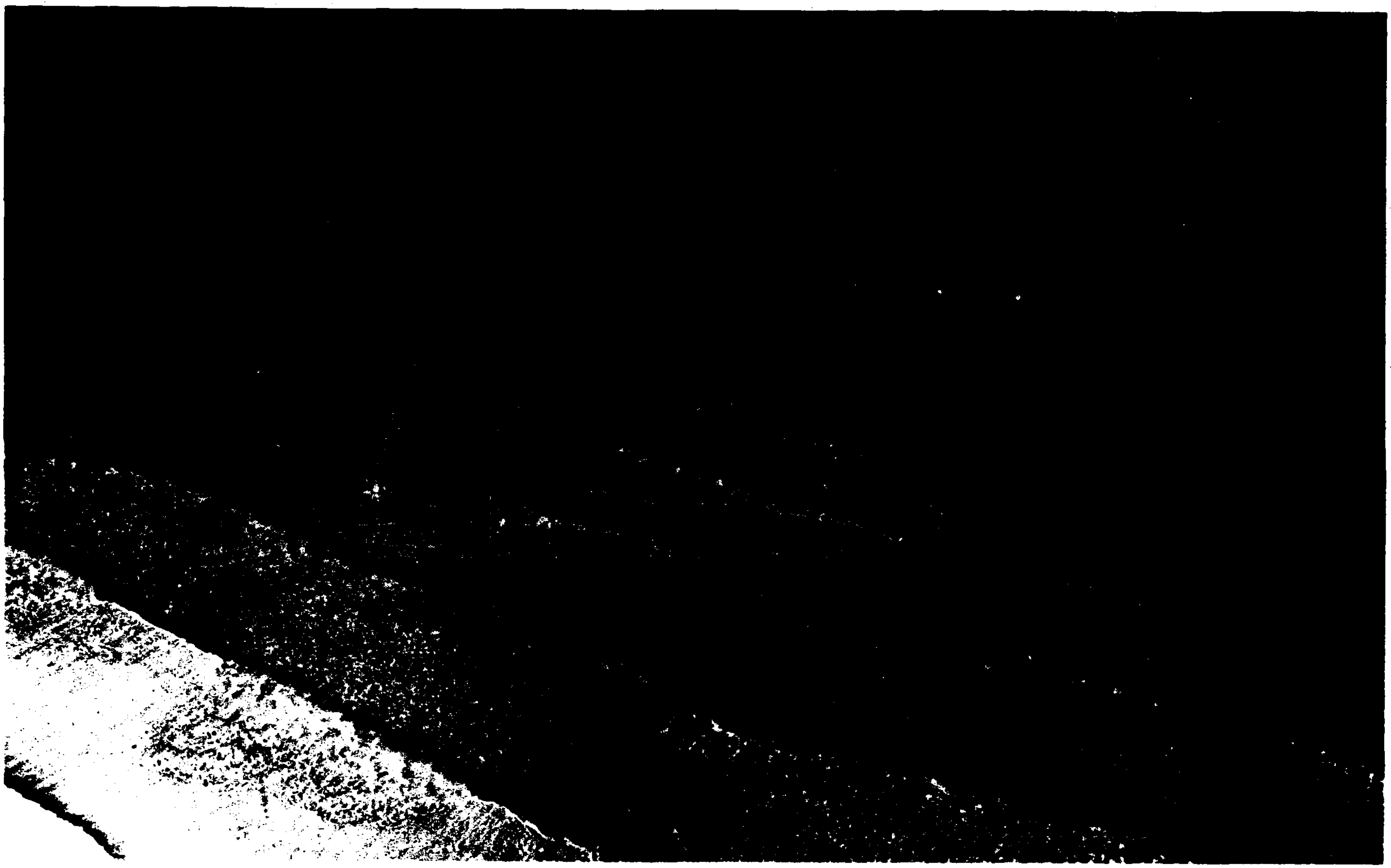


Photo 104. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from west for maximum flood; swl = +4.3 ft

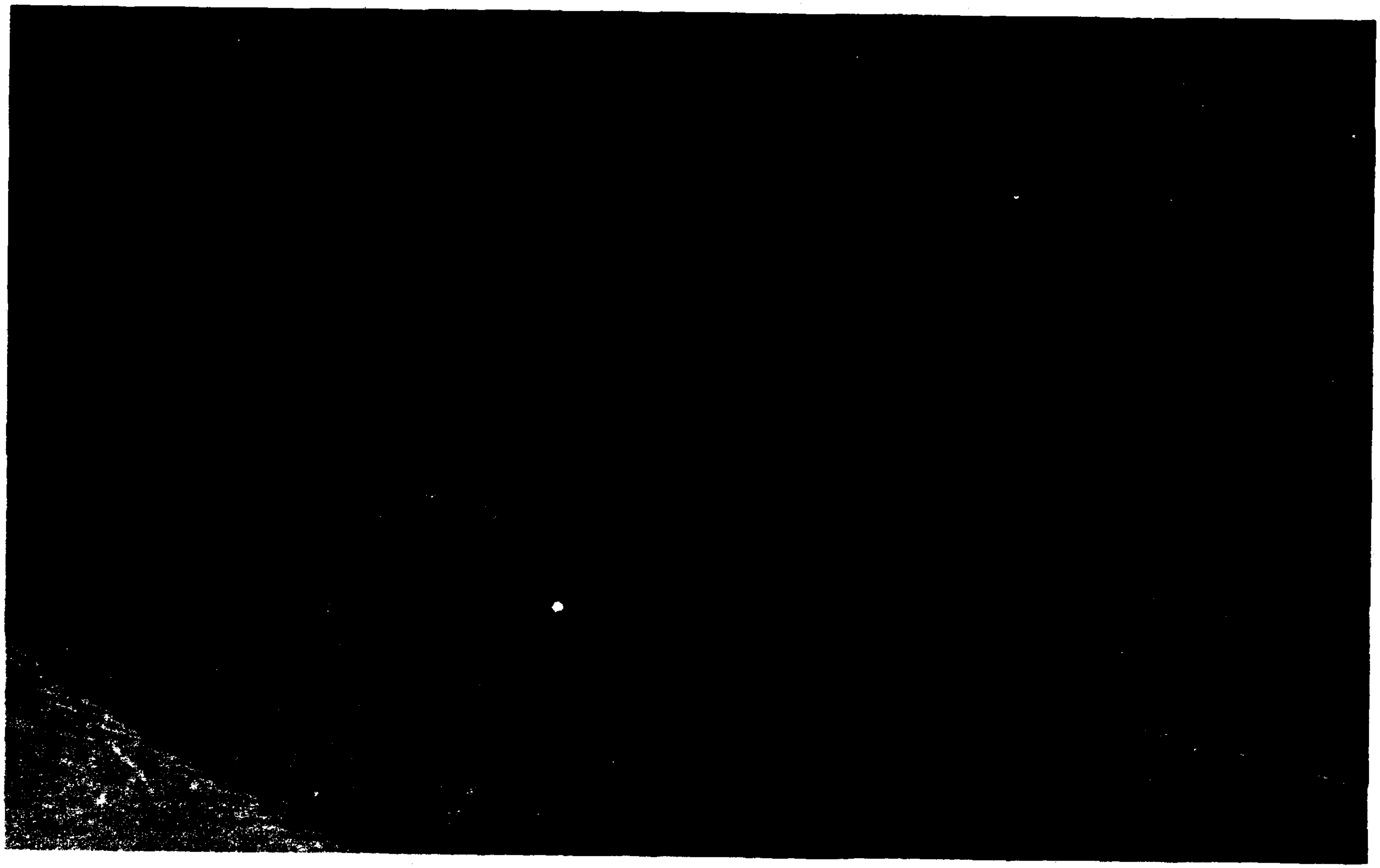


Photo 105. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from west for maximum flood, swl = +4.3 ft

Photo 106. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 23-ft waves from west; swl = +6.7 ft

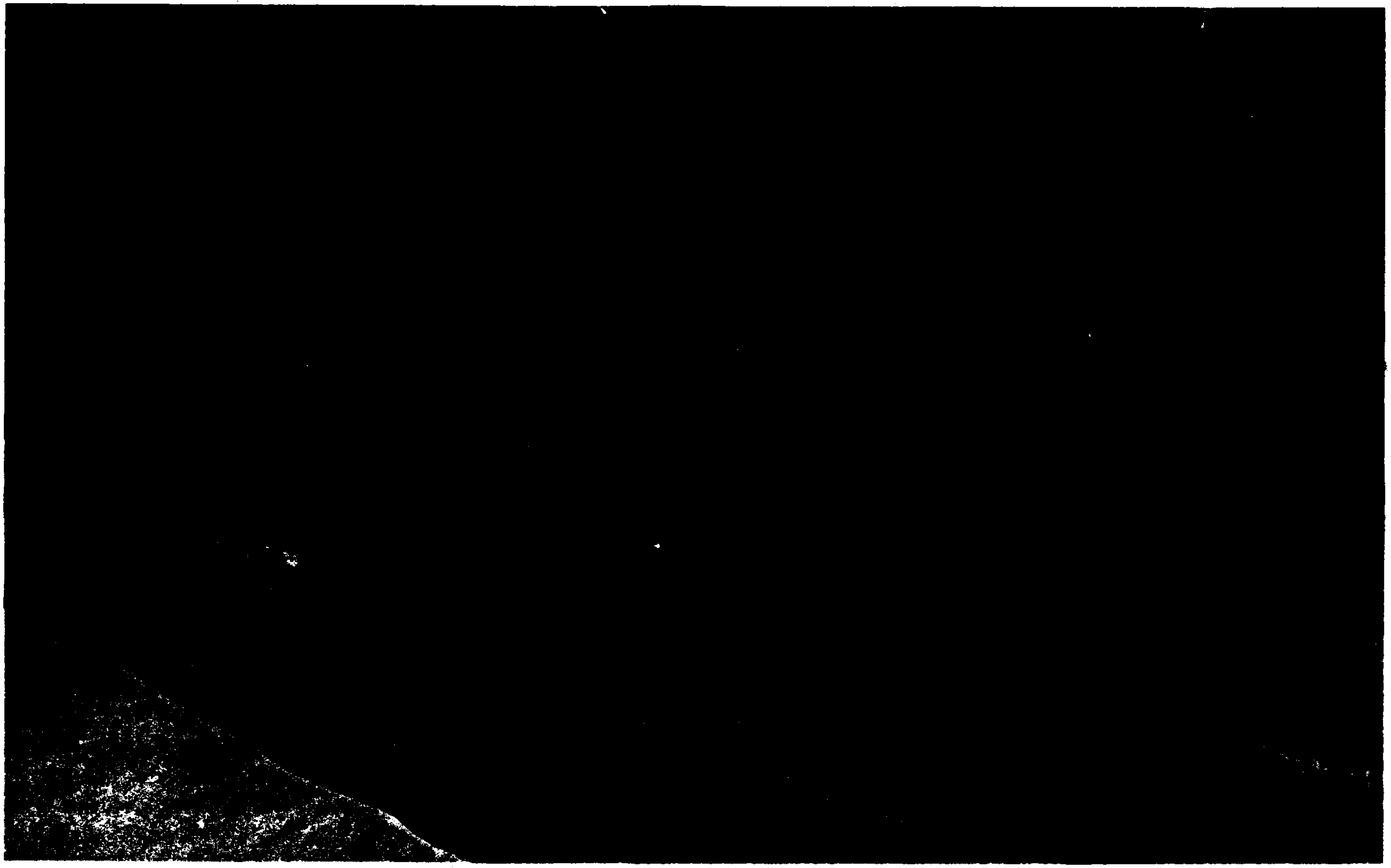


Photo 107. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from west; swl = +6.7 ft

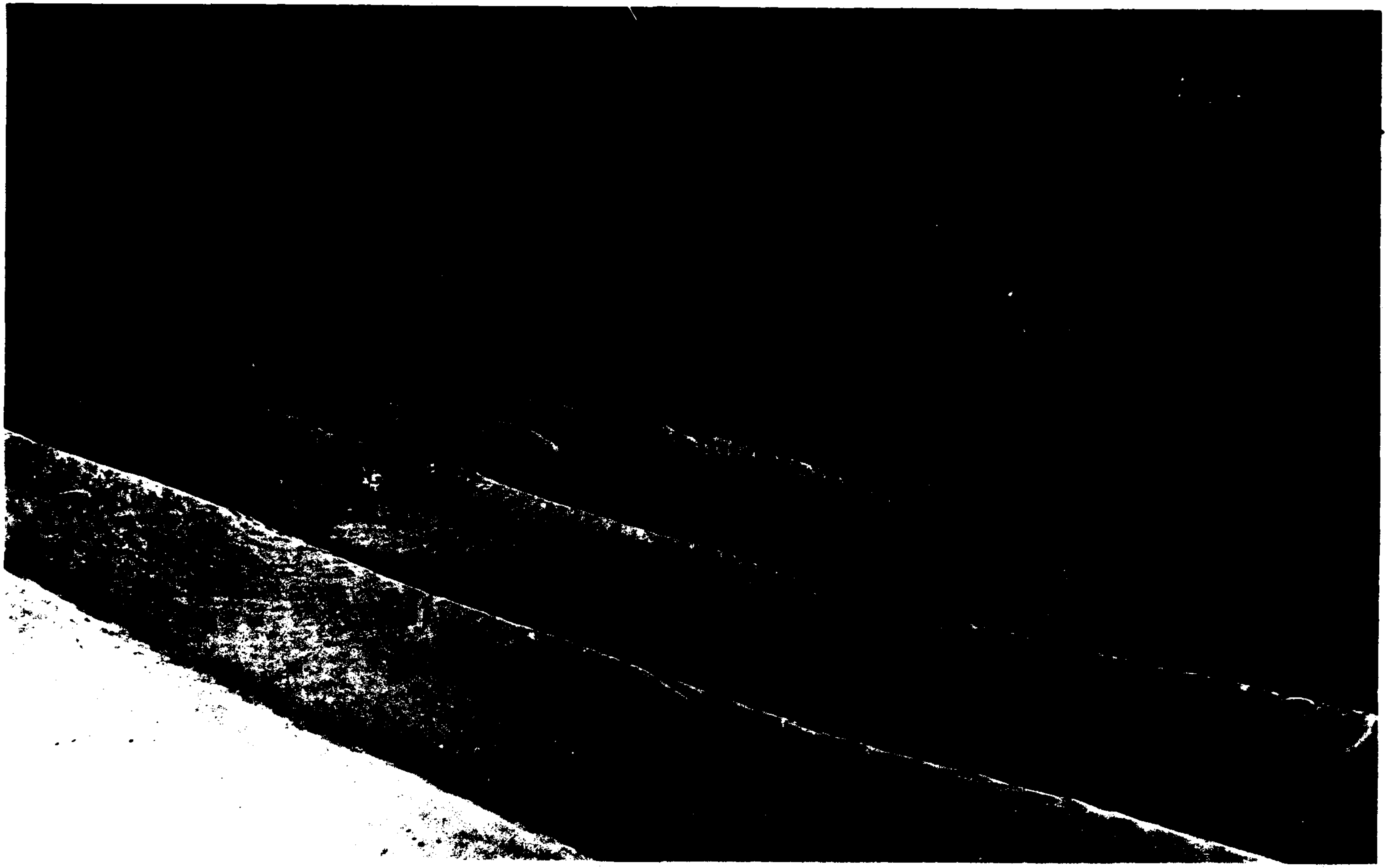


Photo 108. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from west; swl = +6.7 ft

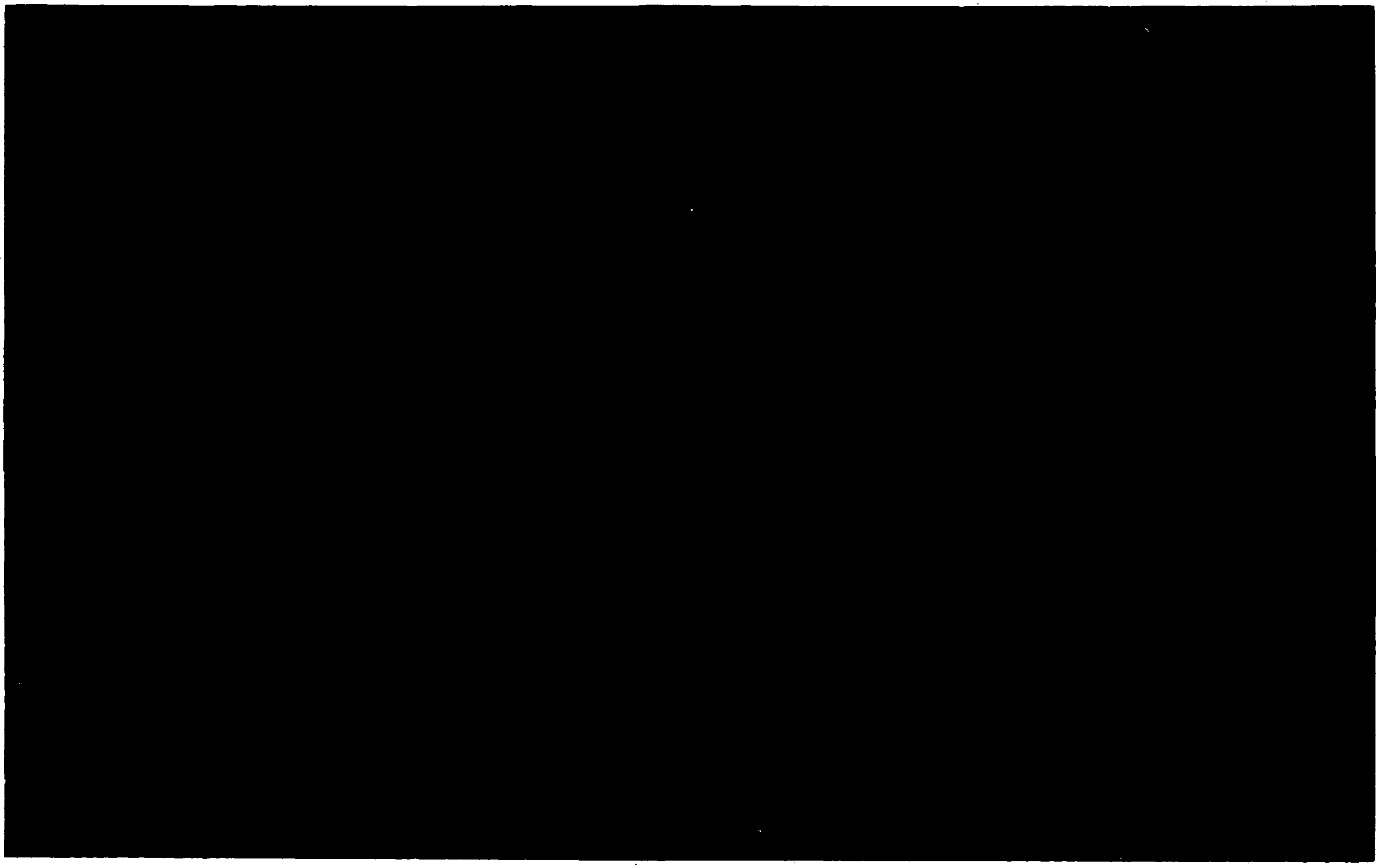


Photo 109. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 7-sec, 12-ft waves from SW for maximum ebb; swl = +1.5 ft

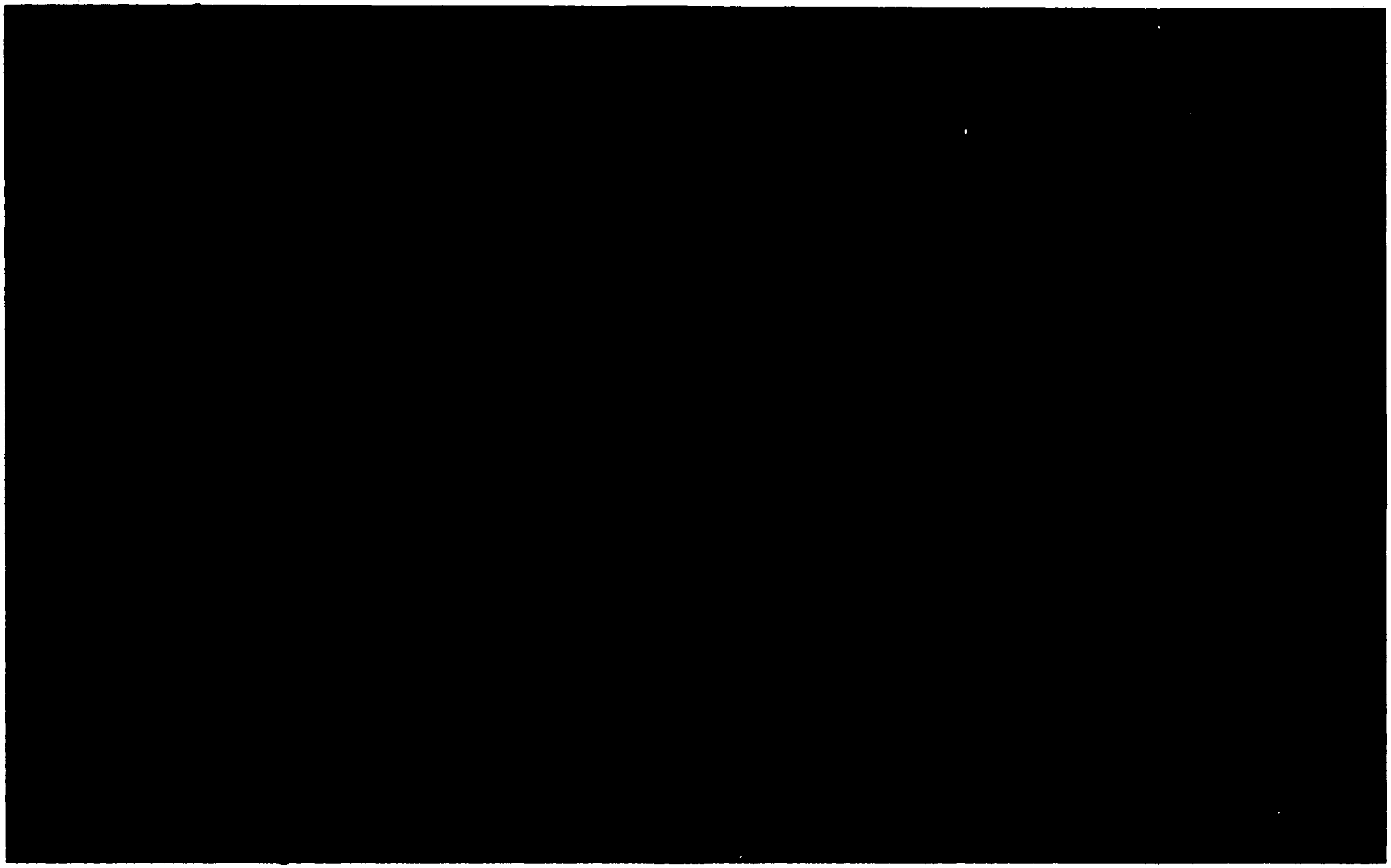


Photo 110. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 21-ft waves from SW for maximum ebb; swl = +1.5 ft

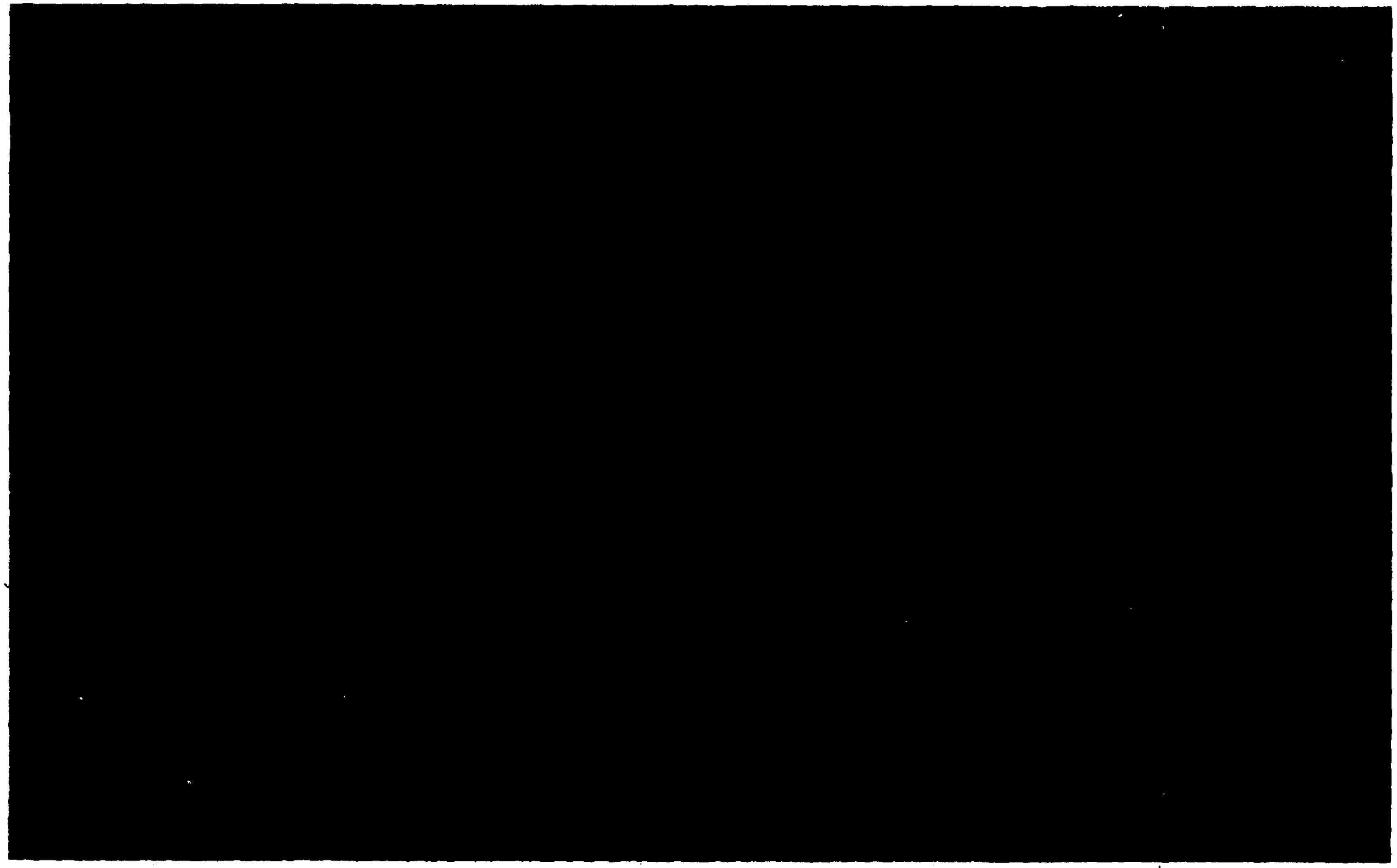


Photo 111. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 13-ft waves from SW for maximum ebb; swl = +1.5 ft

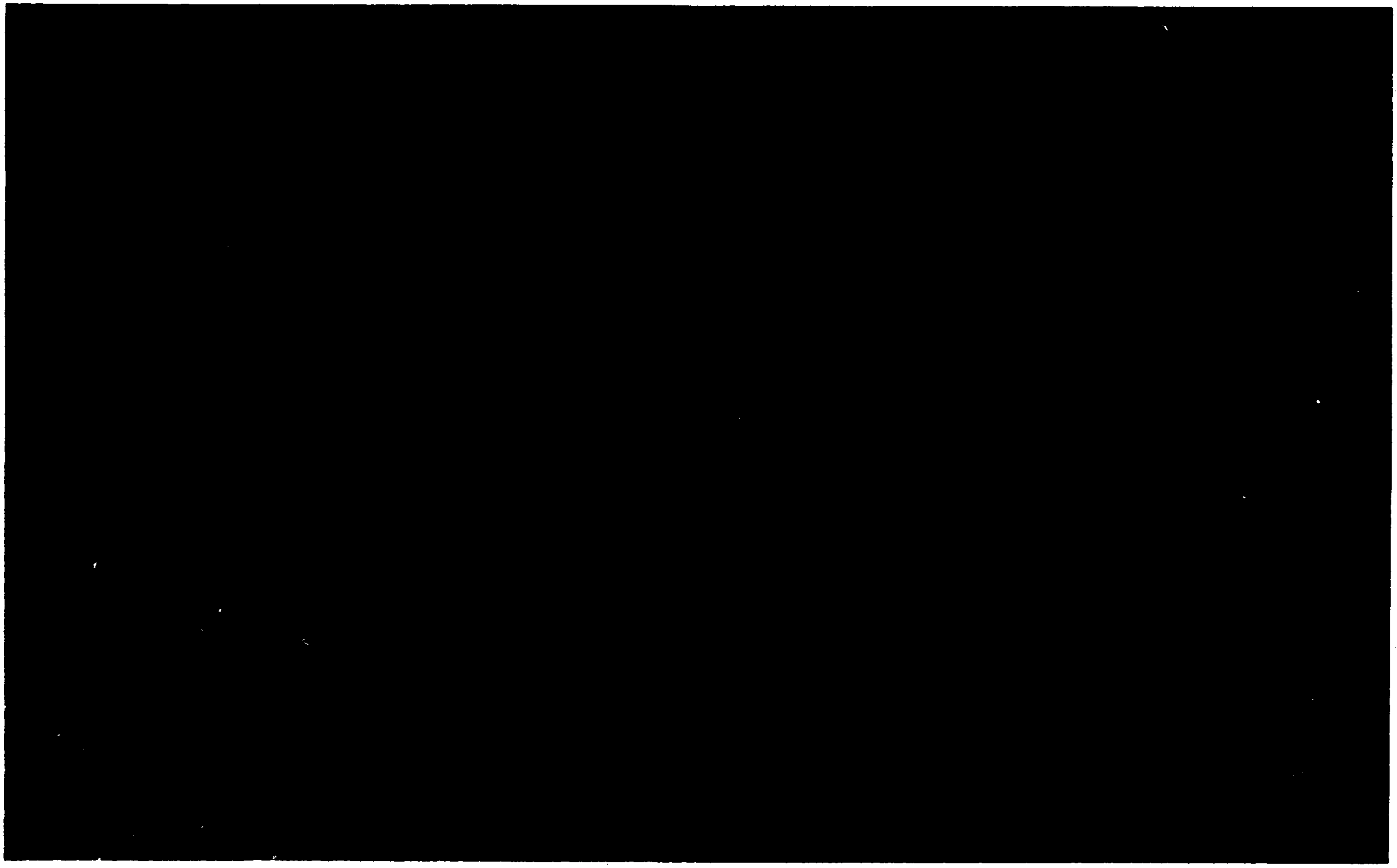


Photo 112. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 21-ft waves from SW for maximum ebb; swl = +1.5 ft

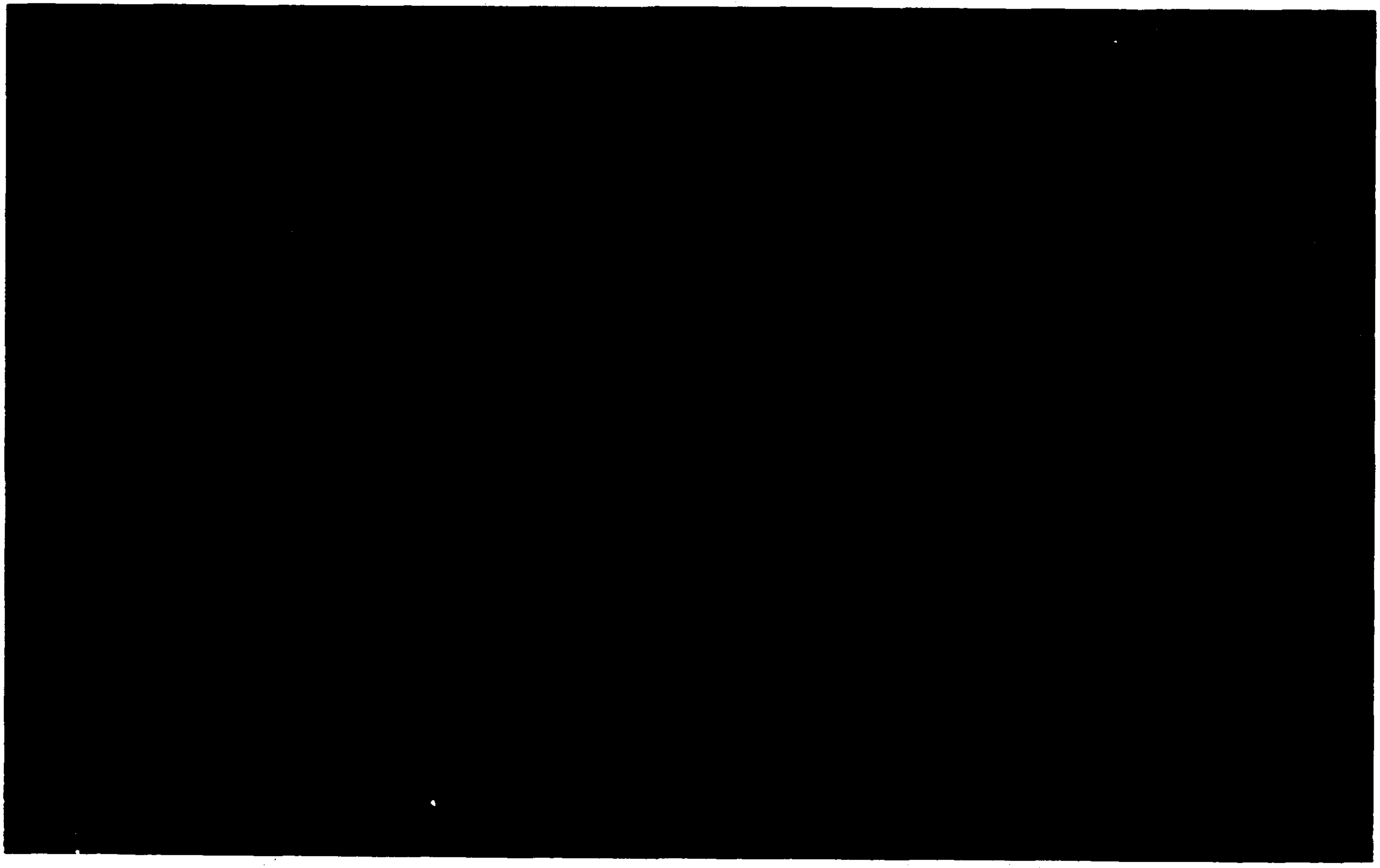


Photo 113. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 17-sec, 7-ft waves from SW for maximum ebb; swl = +1.5 ft

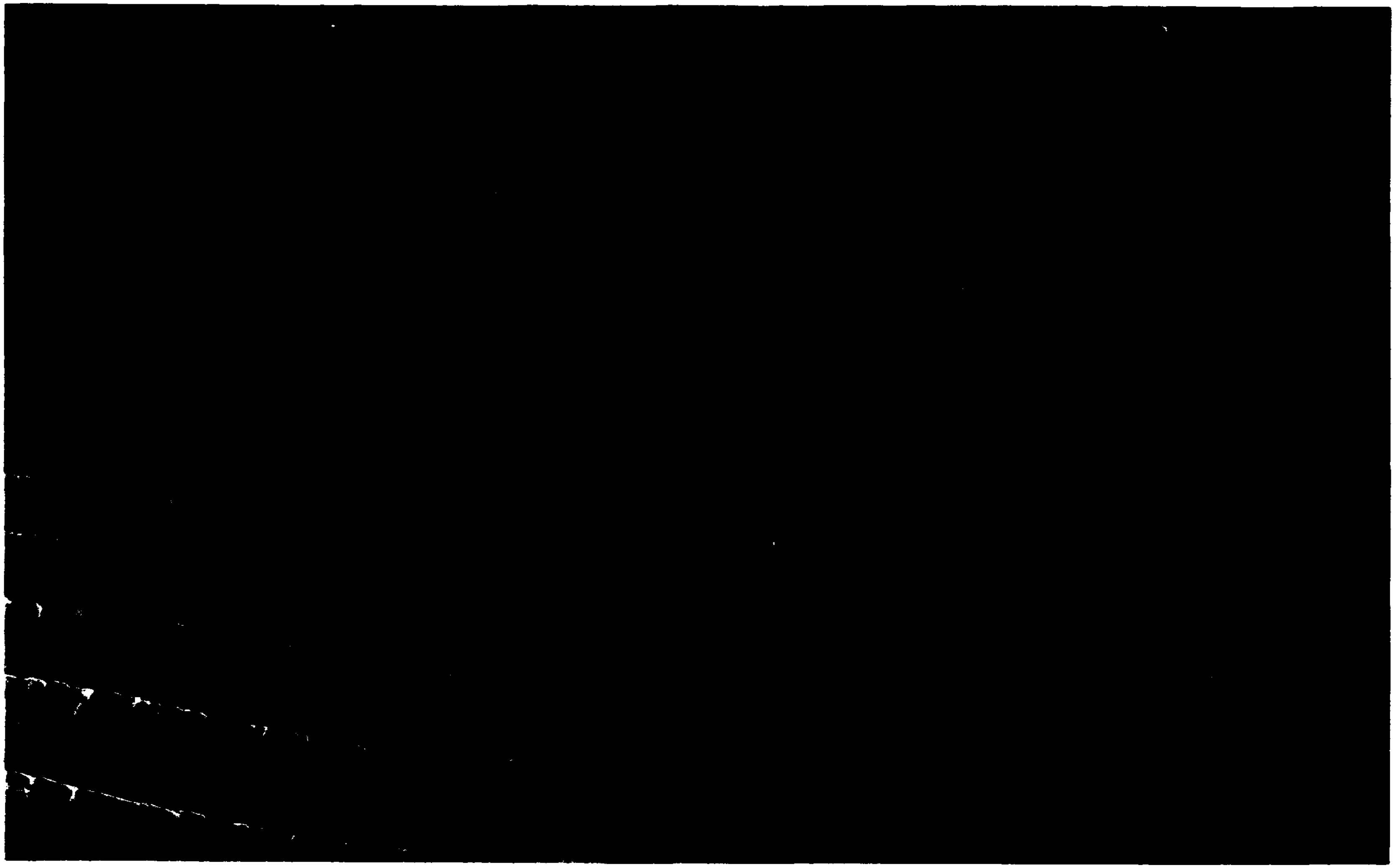


Photo 114. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 7-sec, 12-ft waves from SW for maximum flood; swl = +4.3 ft

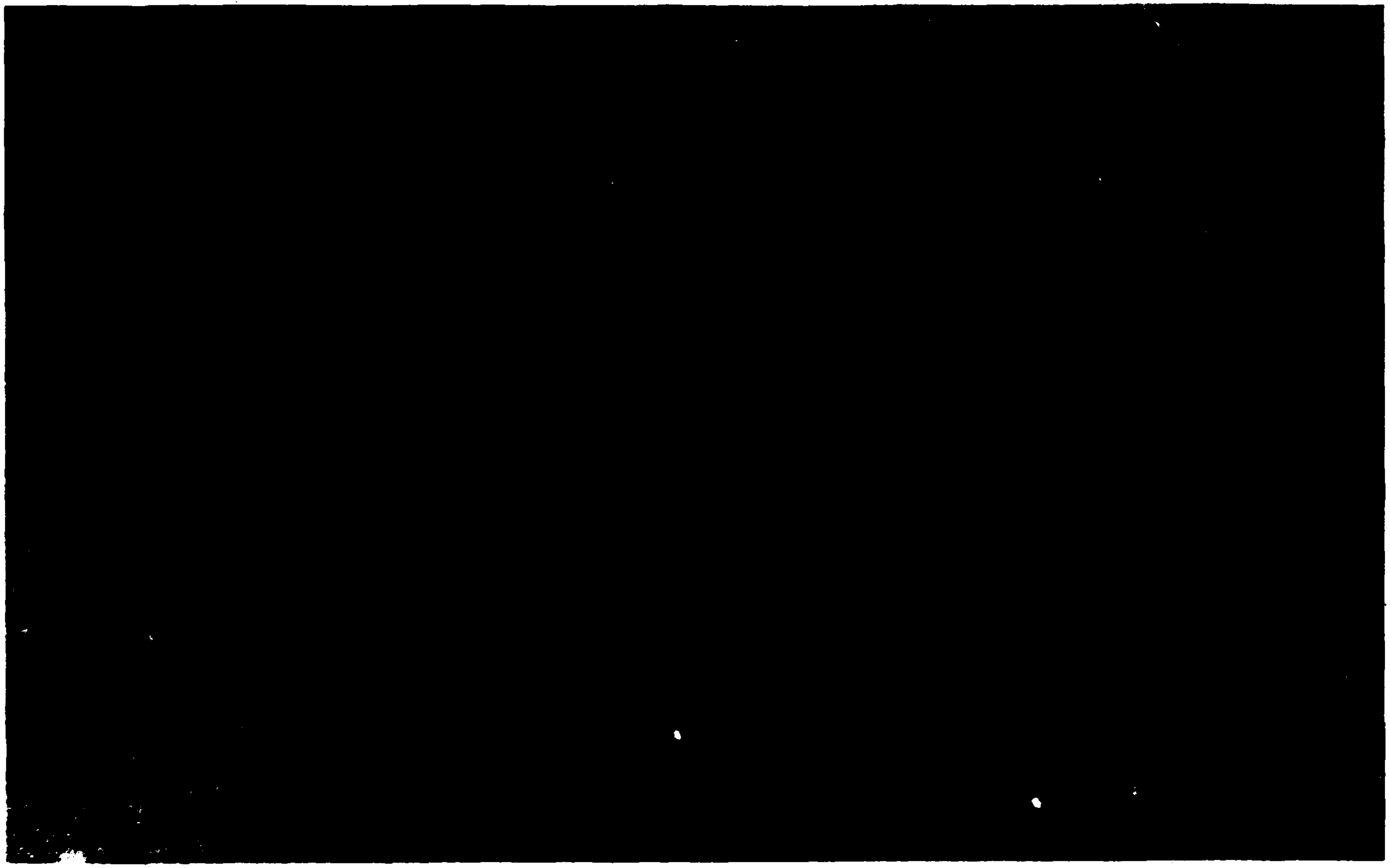


Photo 115. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 21-ft waves from SW for maximum flood; swl = +4.3 ft

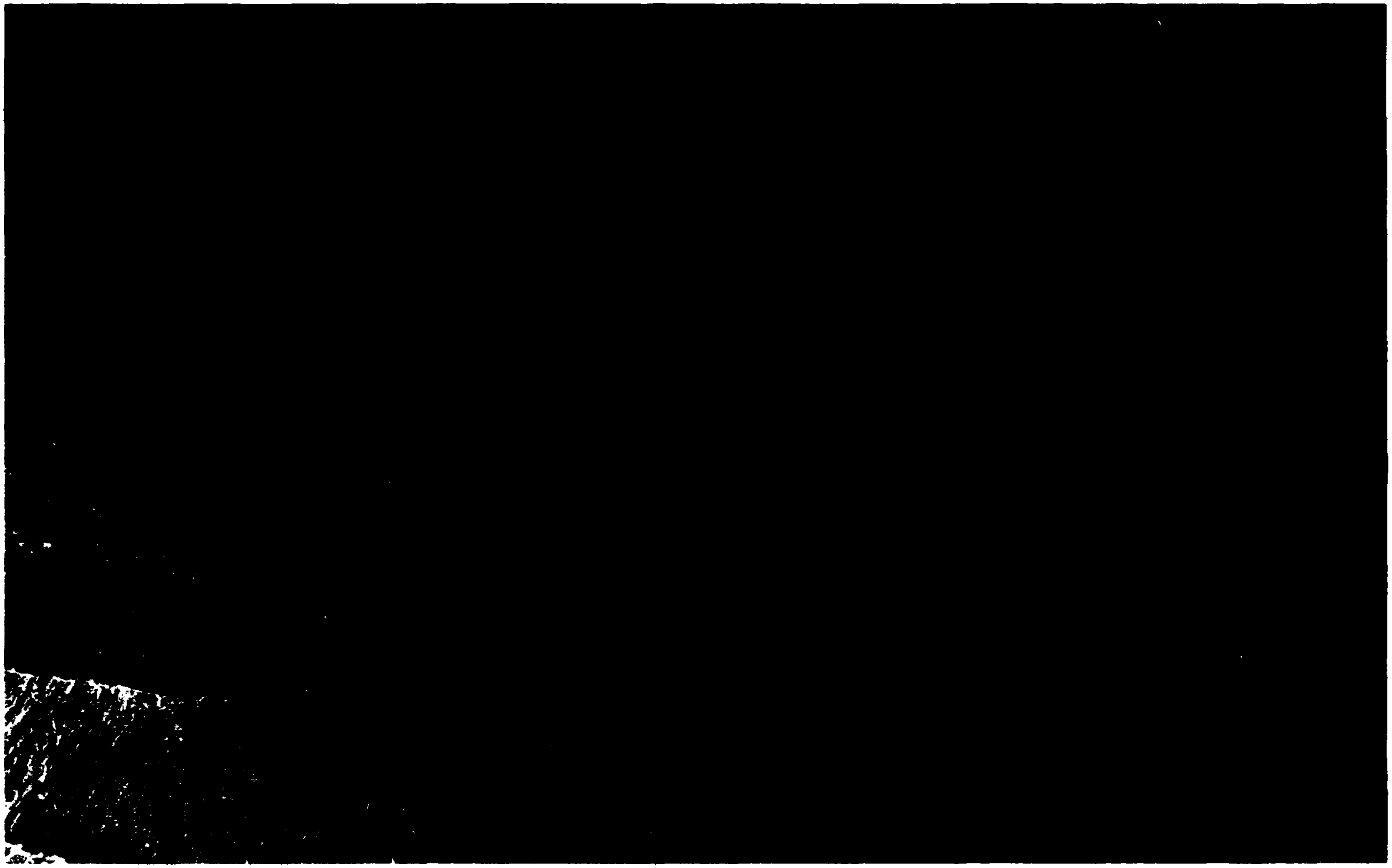


Photo 116. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 13-ft waves from SW for maximum flood; swl = +4.3 ft

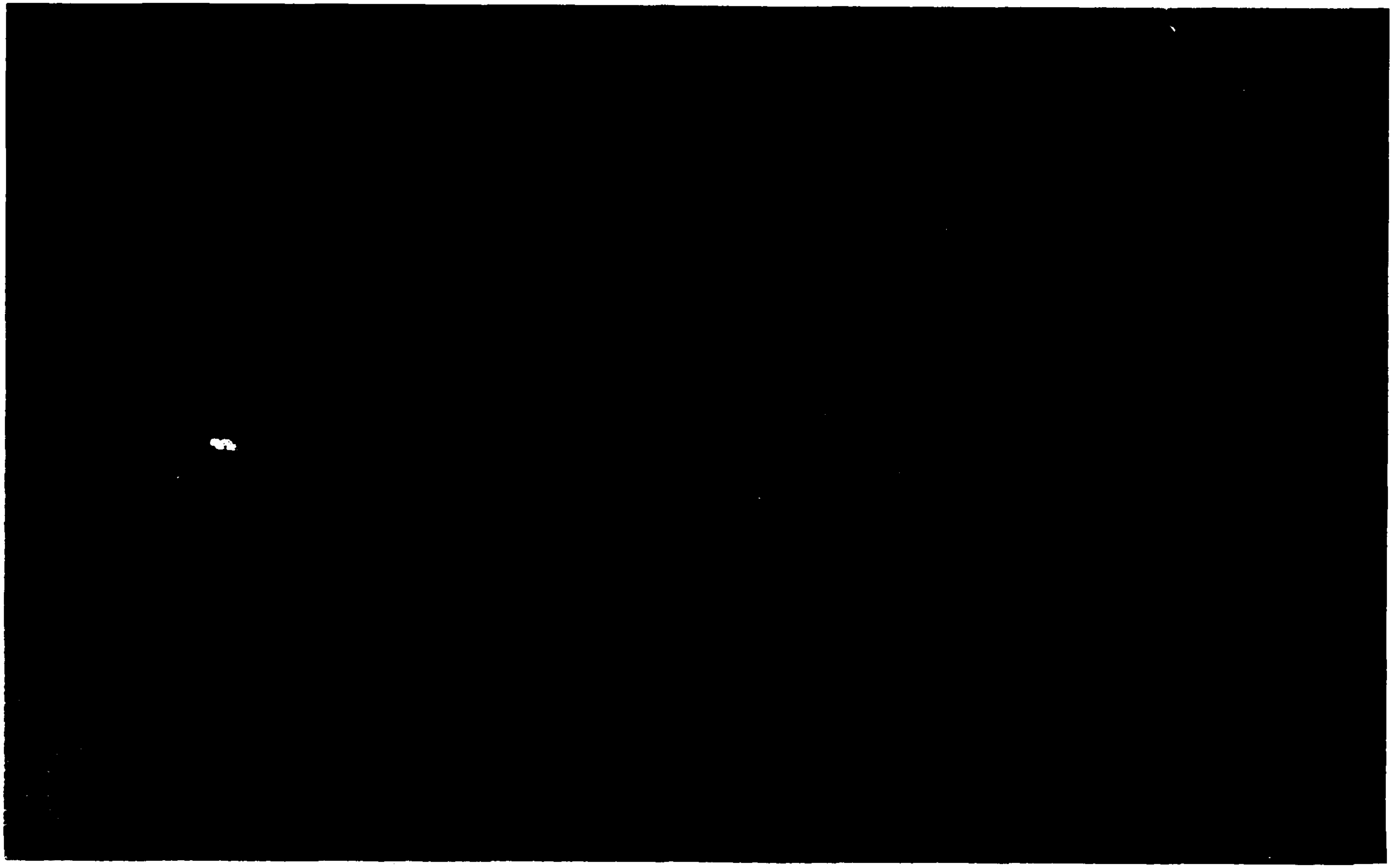


Photo 117. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 21-ft waves from SW for maximum flood; swl = +4.3 ft

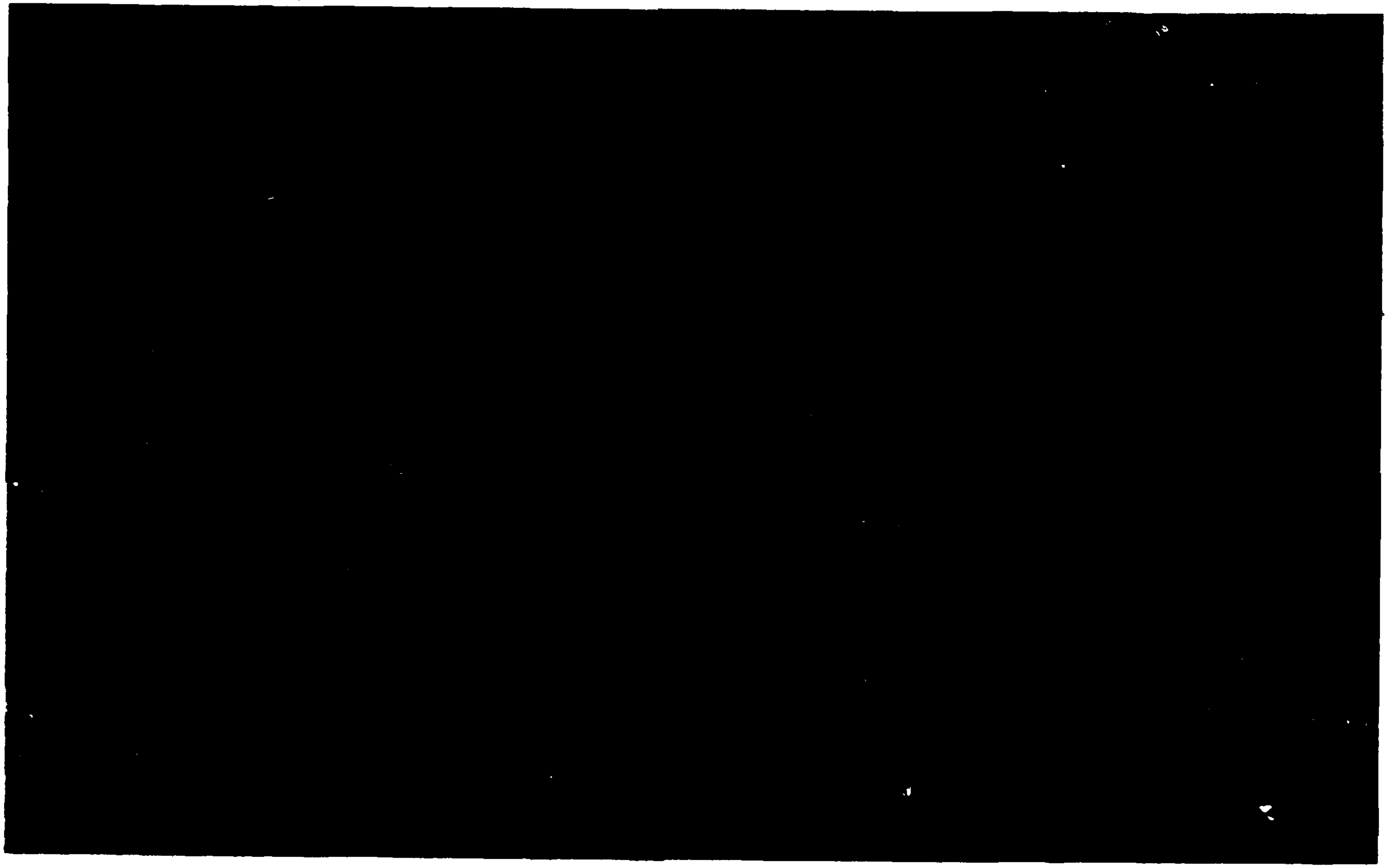


Photo 118. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 17-sec, 7-ft waves from SW for maximum flood; swl = +4.3 ft

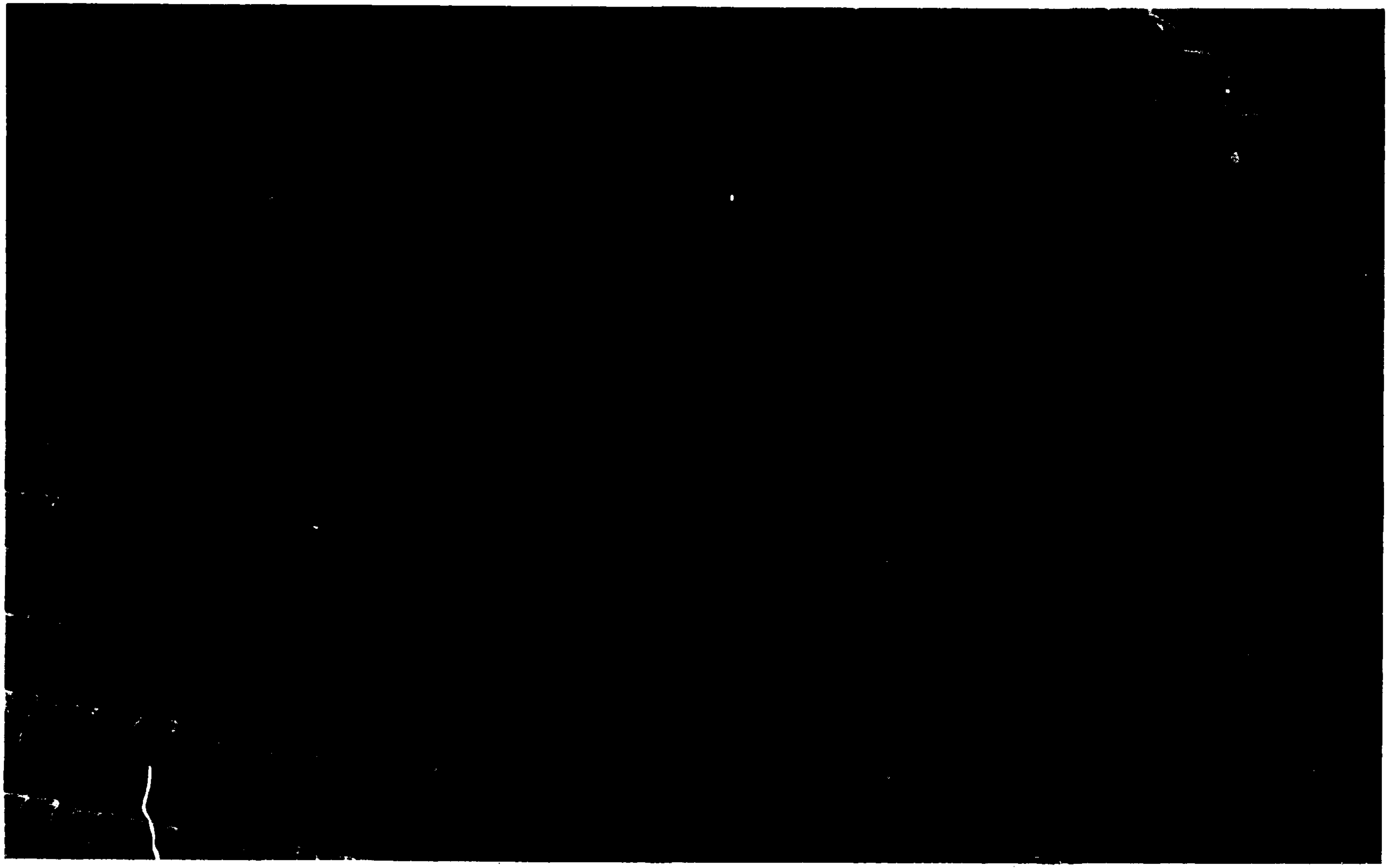


Photo 119. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 7-sec, 12-ft waves from SW; swl = +6.7 ft

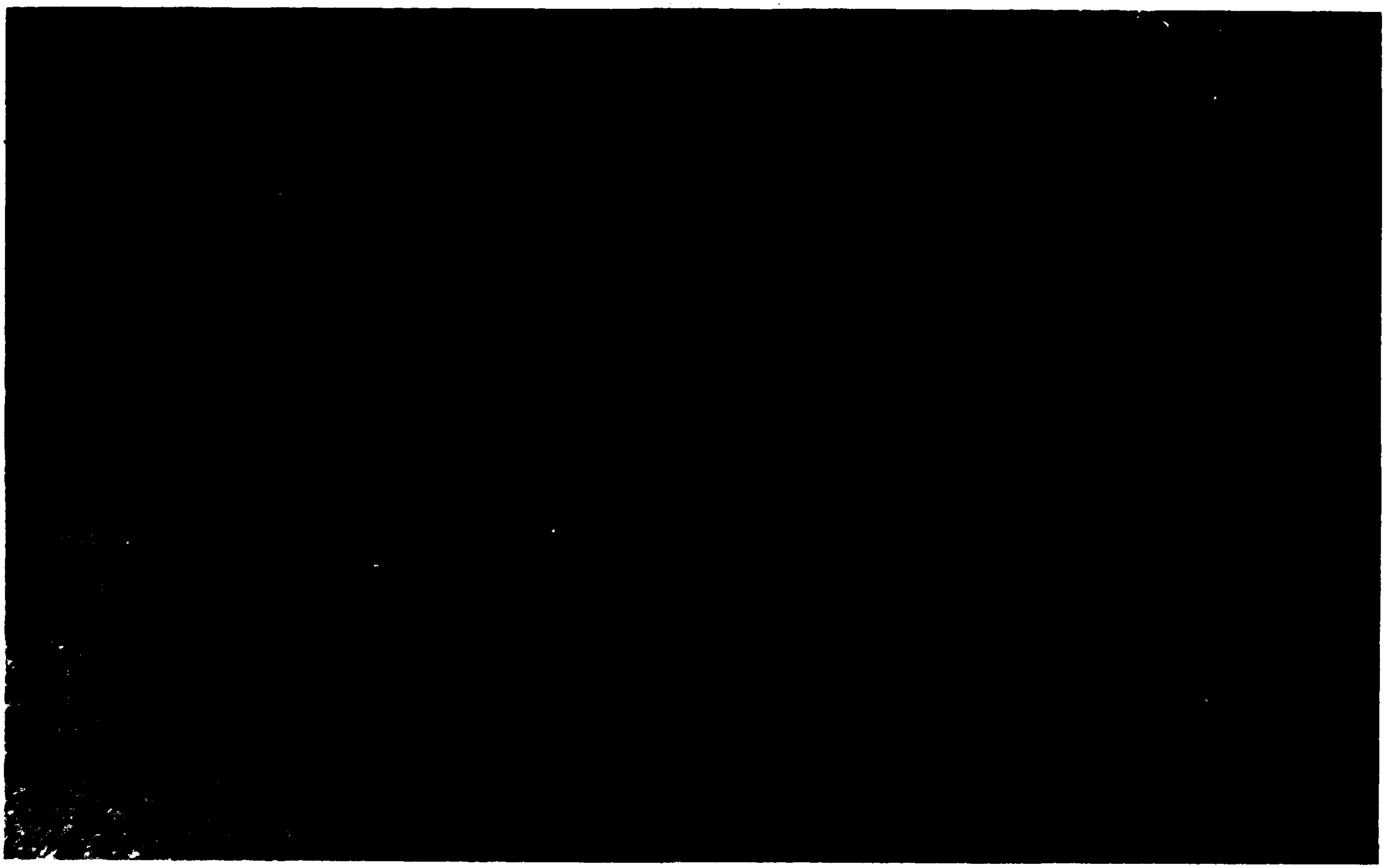


Photo 120. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 21-ft waves from SW; swl = +6.7 ft

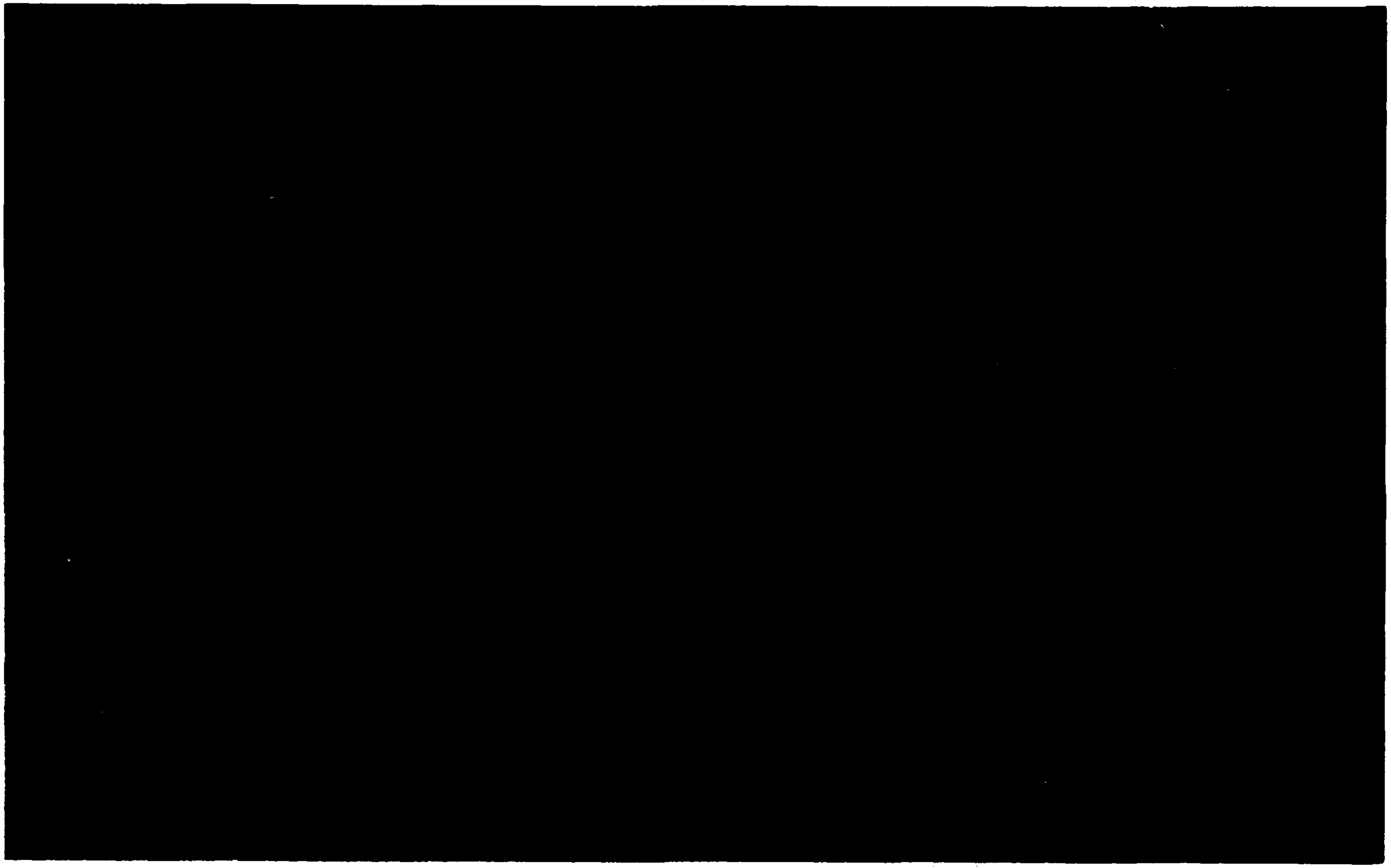


Photo 121. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 13-ft waves from SW; swl = +6.7 ft

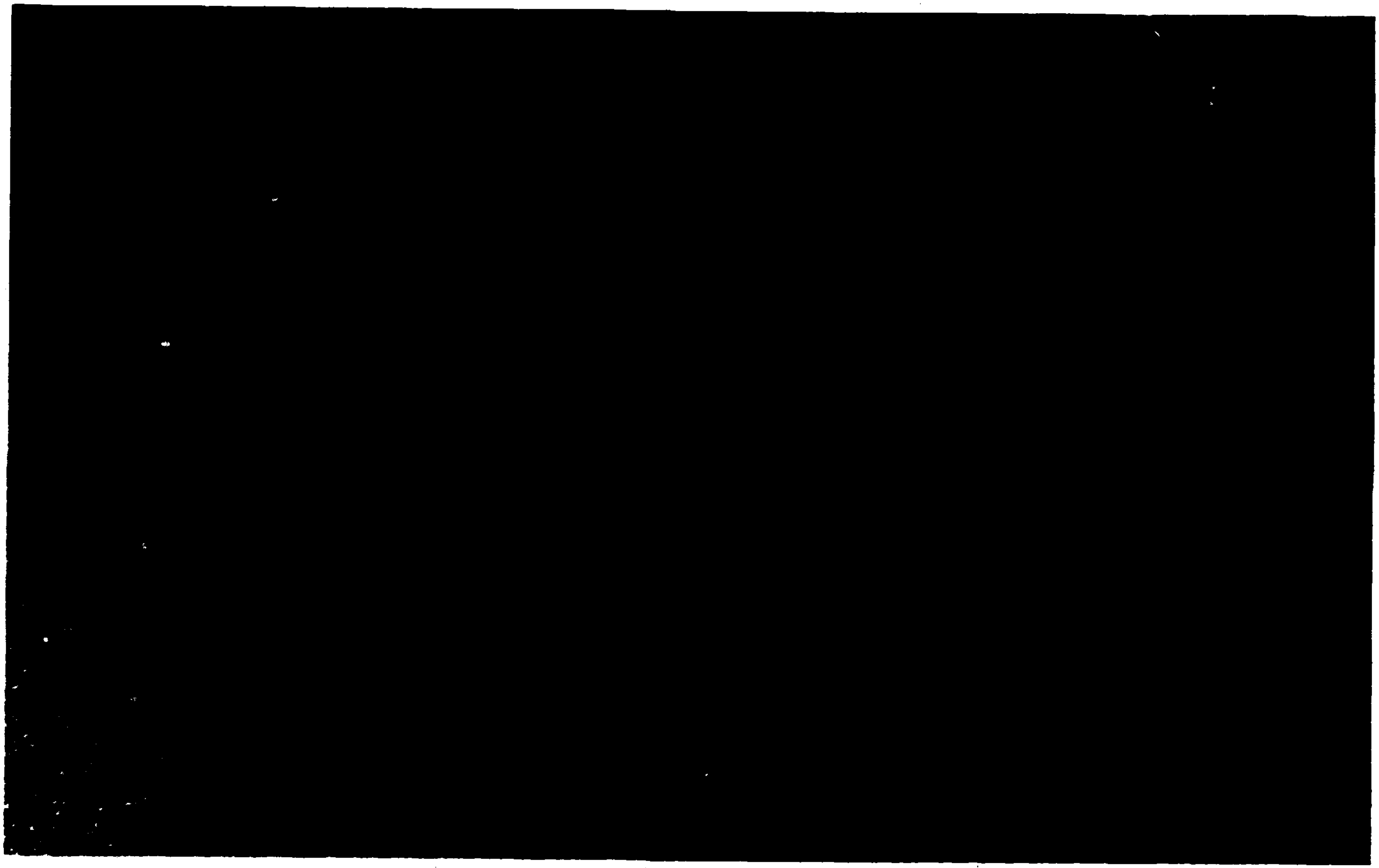


Photo 122. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 21-ft waves from SW; swl = +6.7 ft

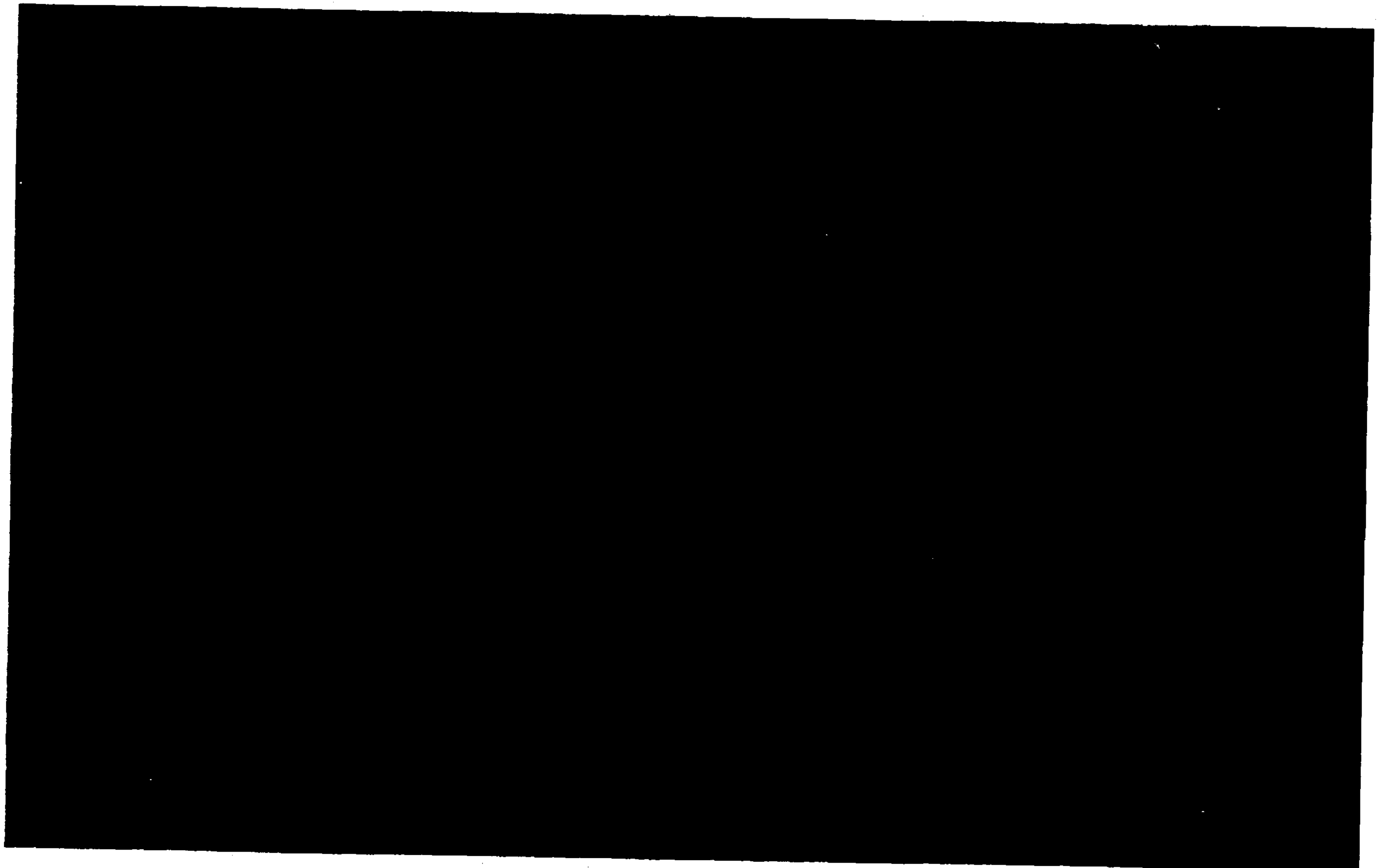


Photo 123. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 17-sec, 7-ft waves from SW; swl = +6.7 ft

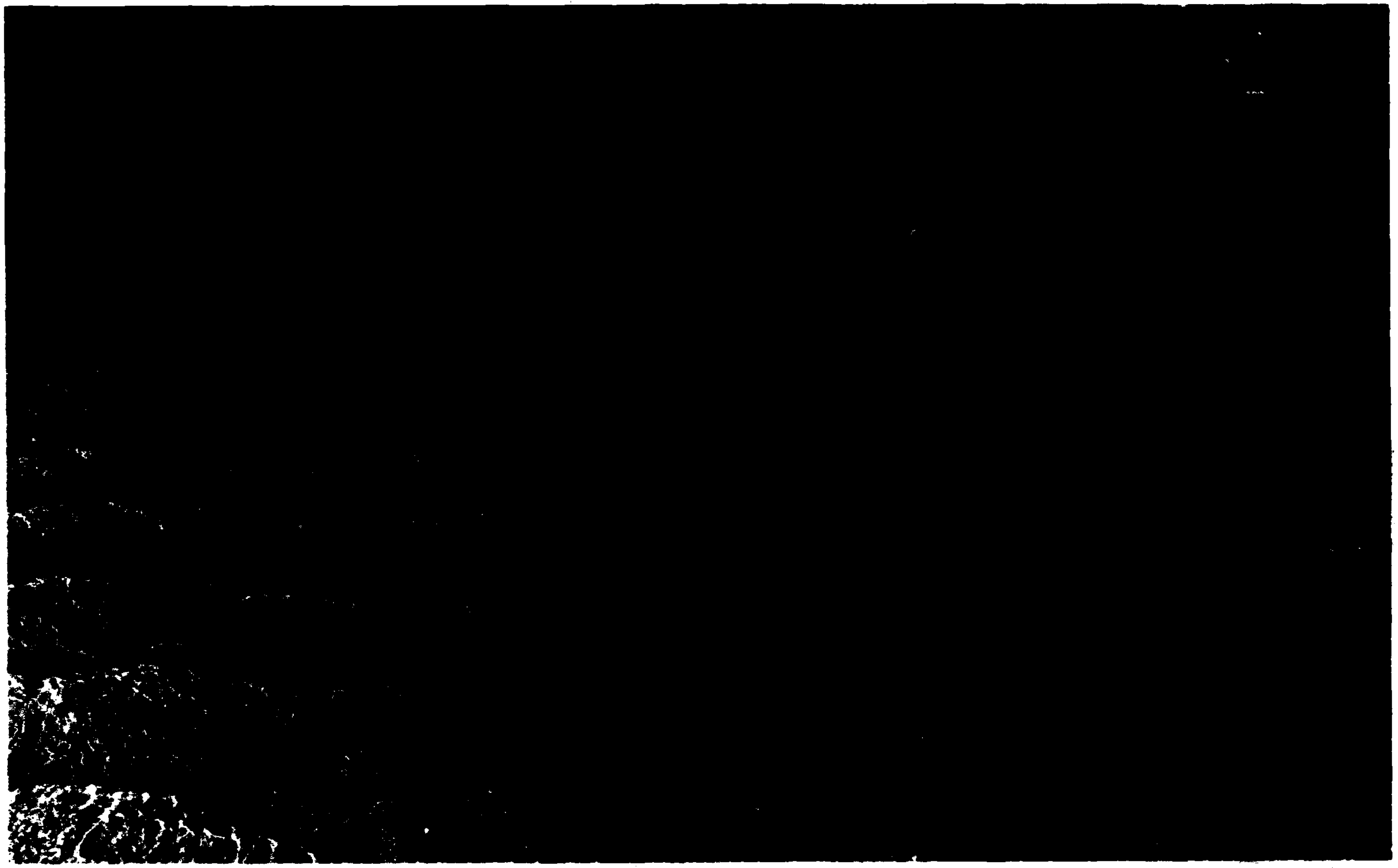


Photo 124. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 27-ft waves from SSW for maximum ebb; swl = +1.5 ft

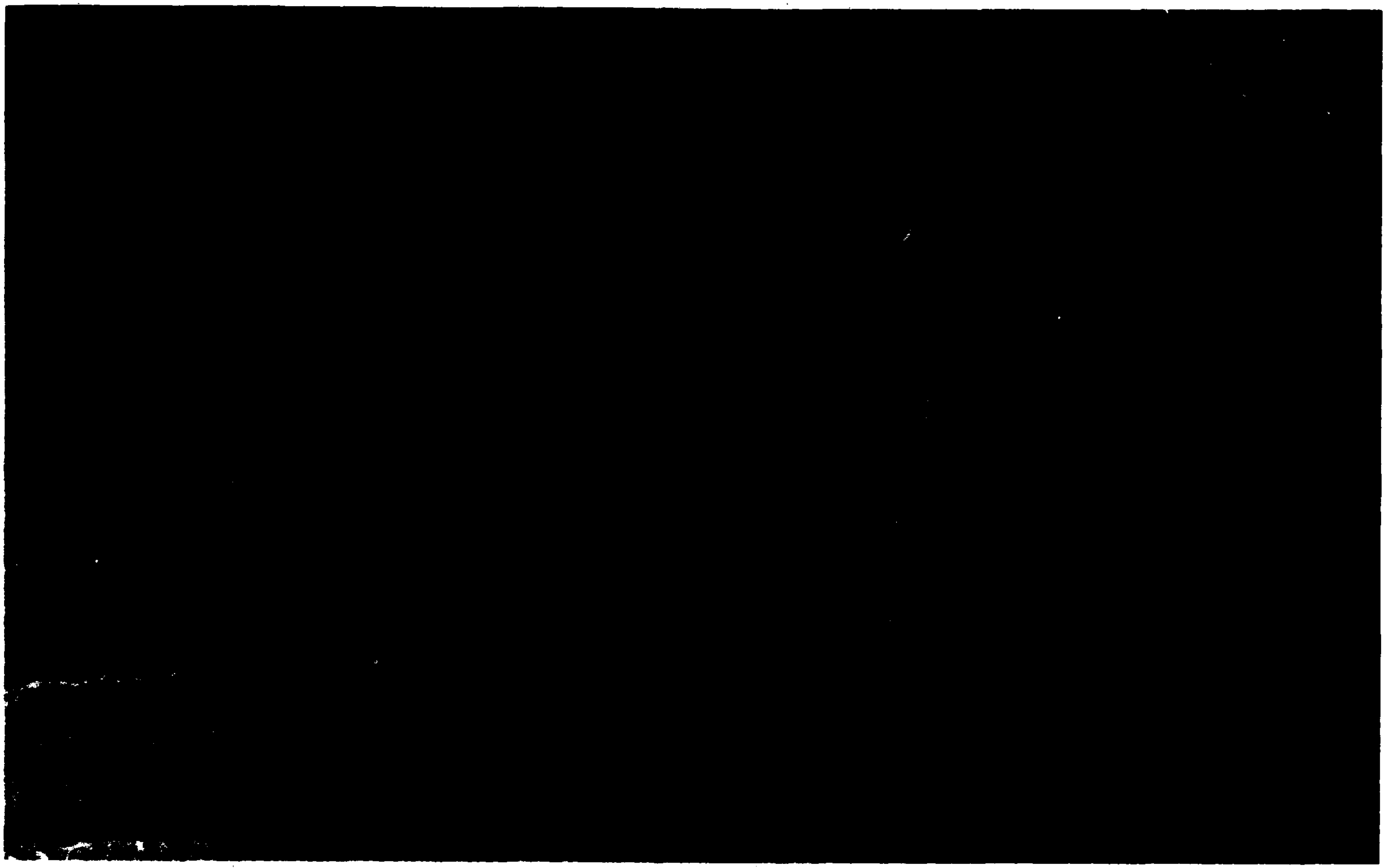


Photo 125. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from SSW for maximum ebb; swl = +1.5 ft

Photo 126. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from SSW for maximum ebb; swl = +1.5 ft

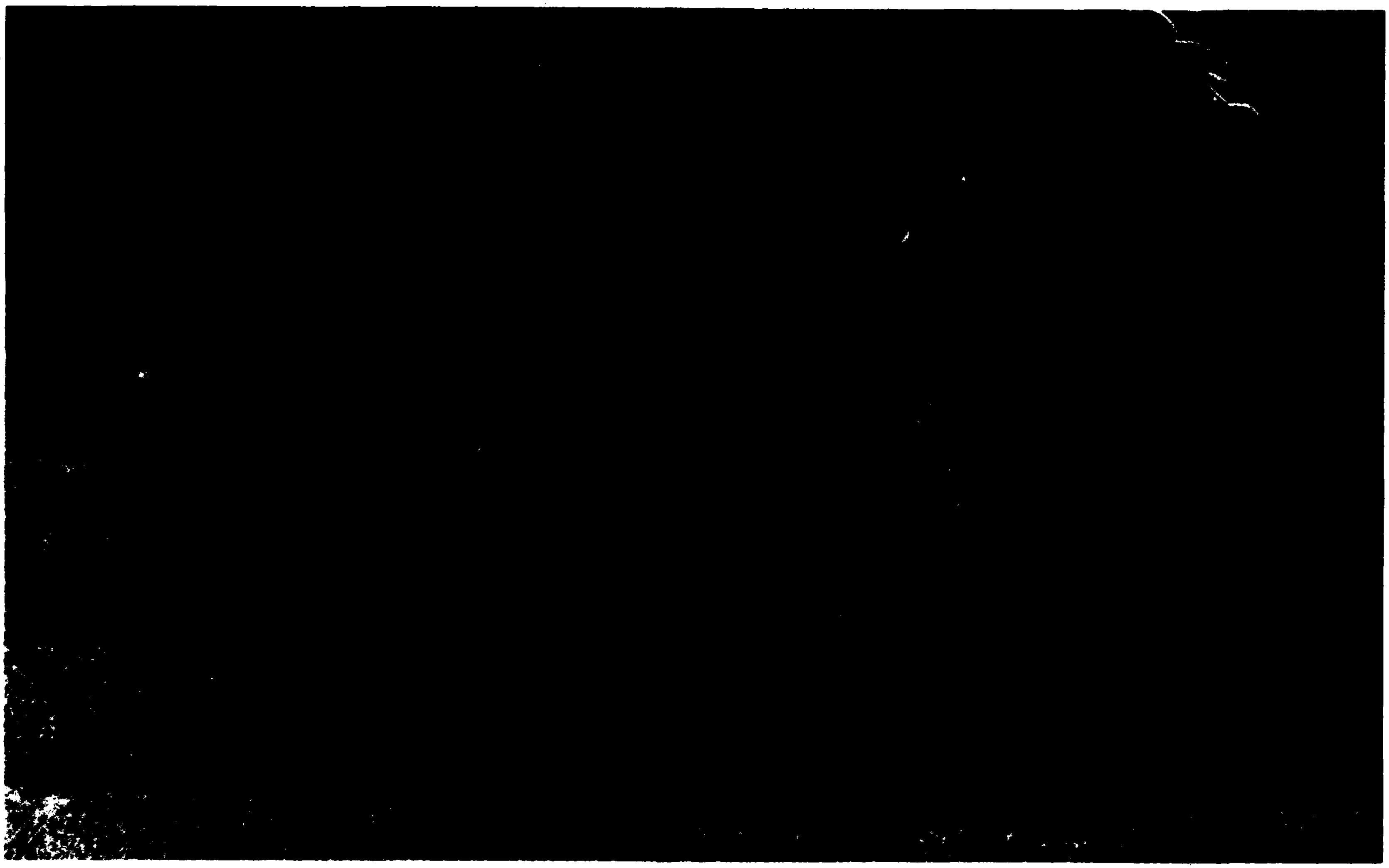


Photo 127. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 9-sec, 27-ft waves from SSW for maximum flood; swl = +4.3 ft

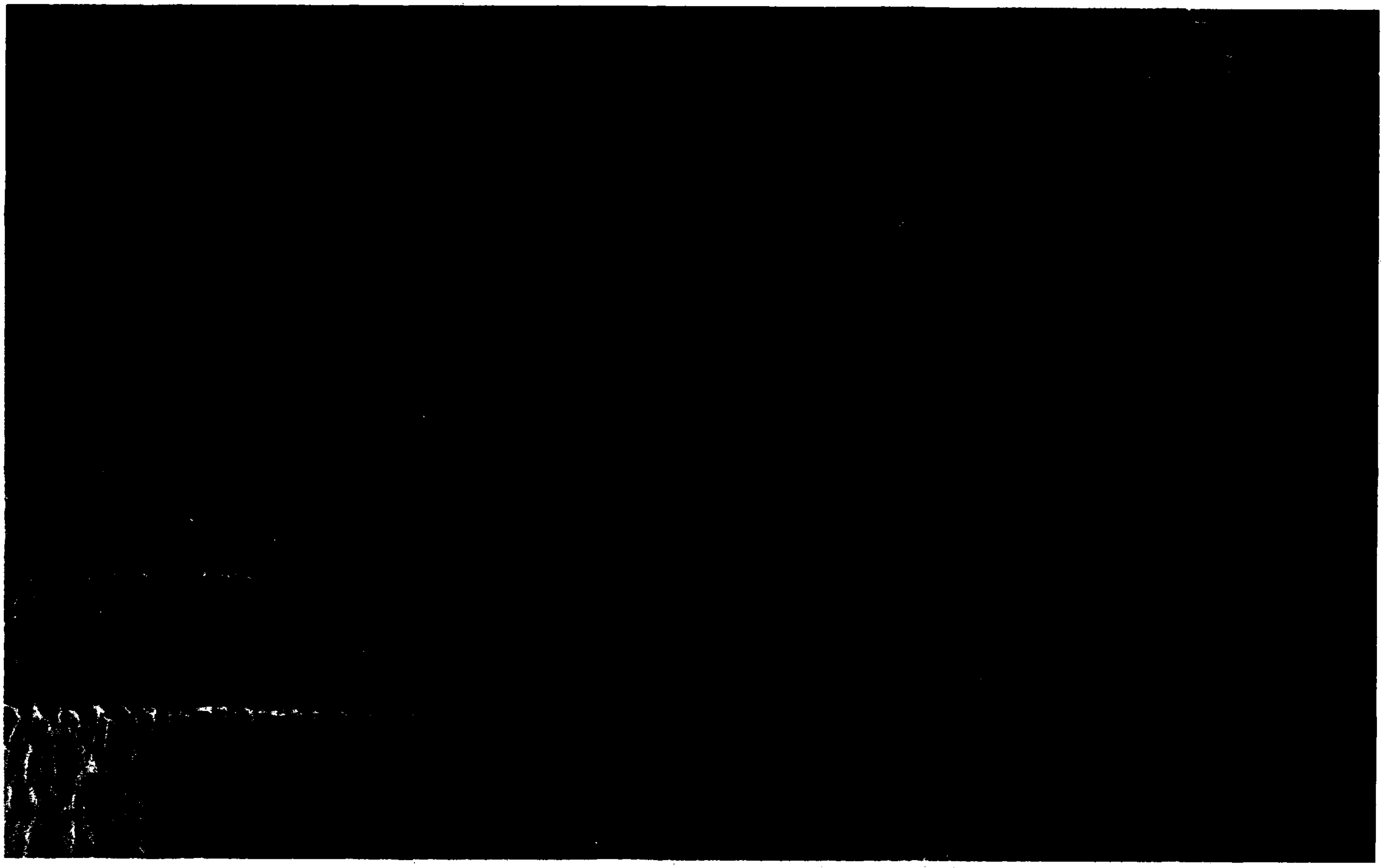


Photo 128. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from SSW for maximum flood; swl = +4.3 ft

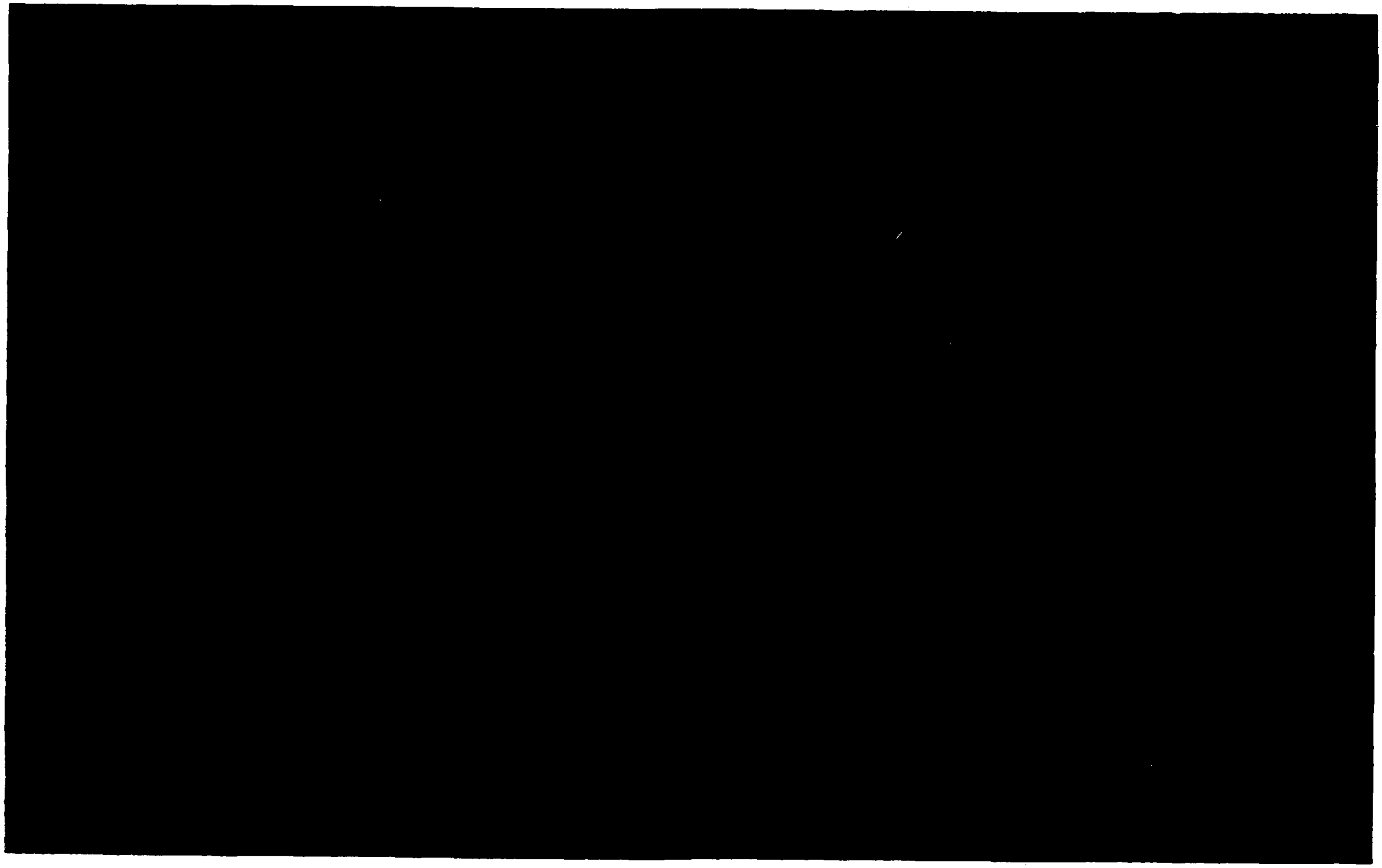


Photo 129. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from SSW for maximum flood; swl = +4.3 ft

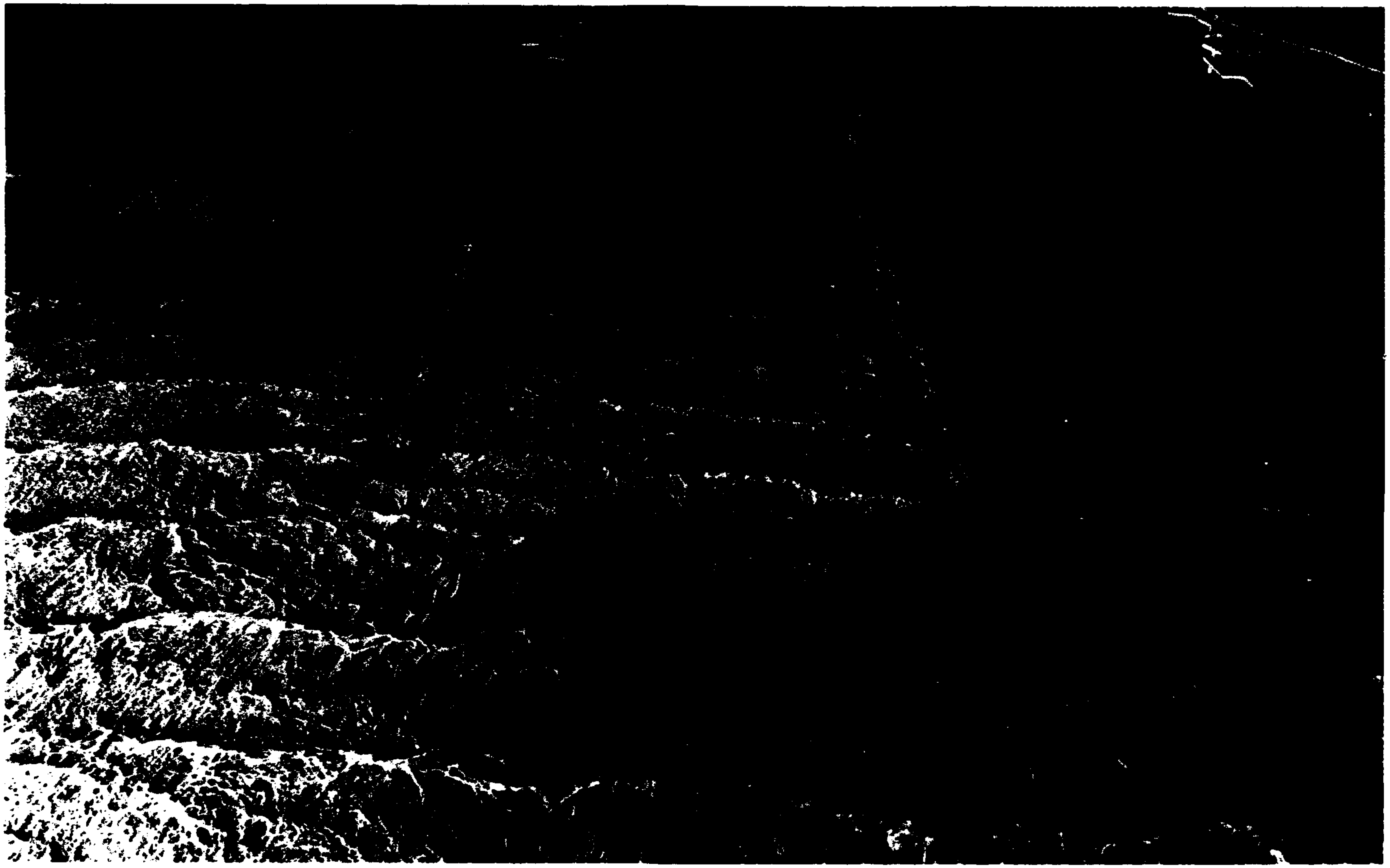


Photo 130. Typical wave patterns, current patterns, and current magnitude (prototype feet per second) for Base Test 2; 9-sec, 27-ft waves from SSW; swl = +6.7 ft

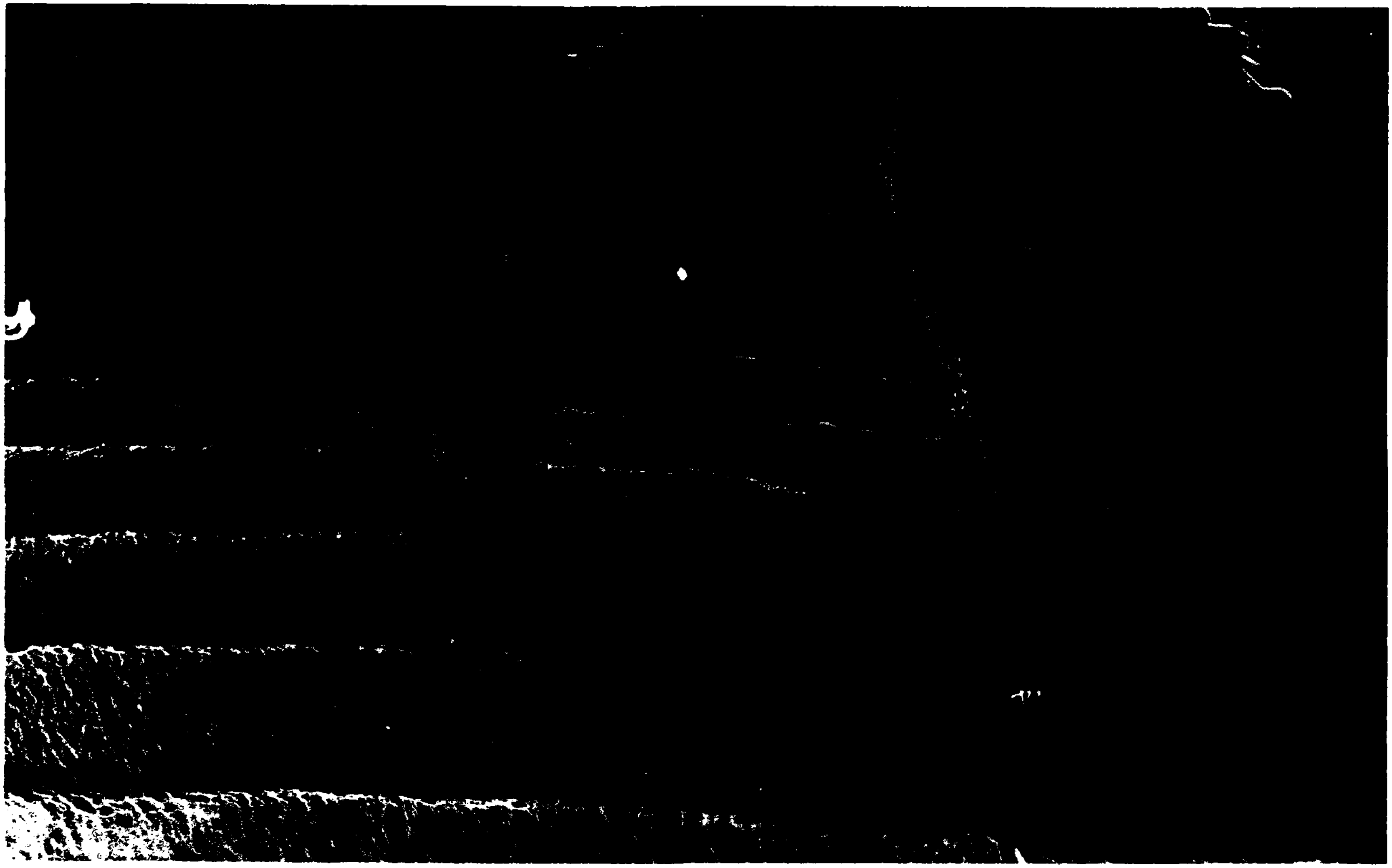


Photo 131. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 11-sec, 12-ft waves from SSW; swl = +6.7 ft

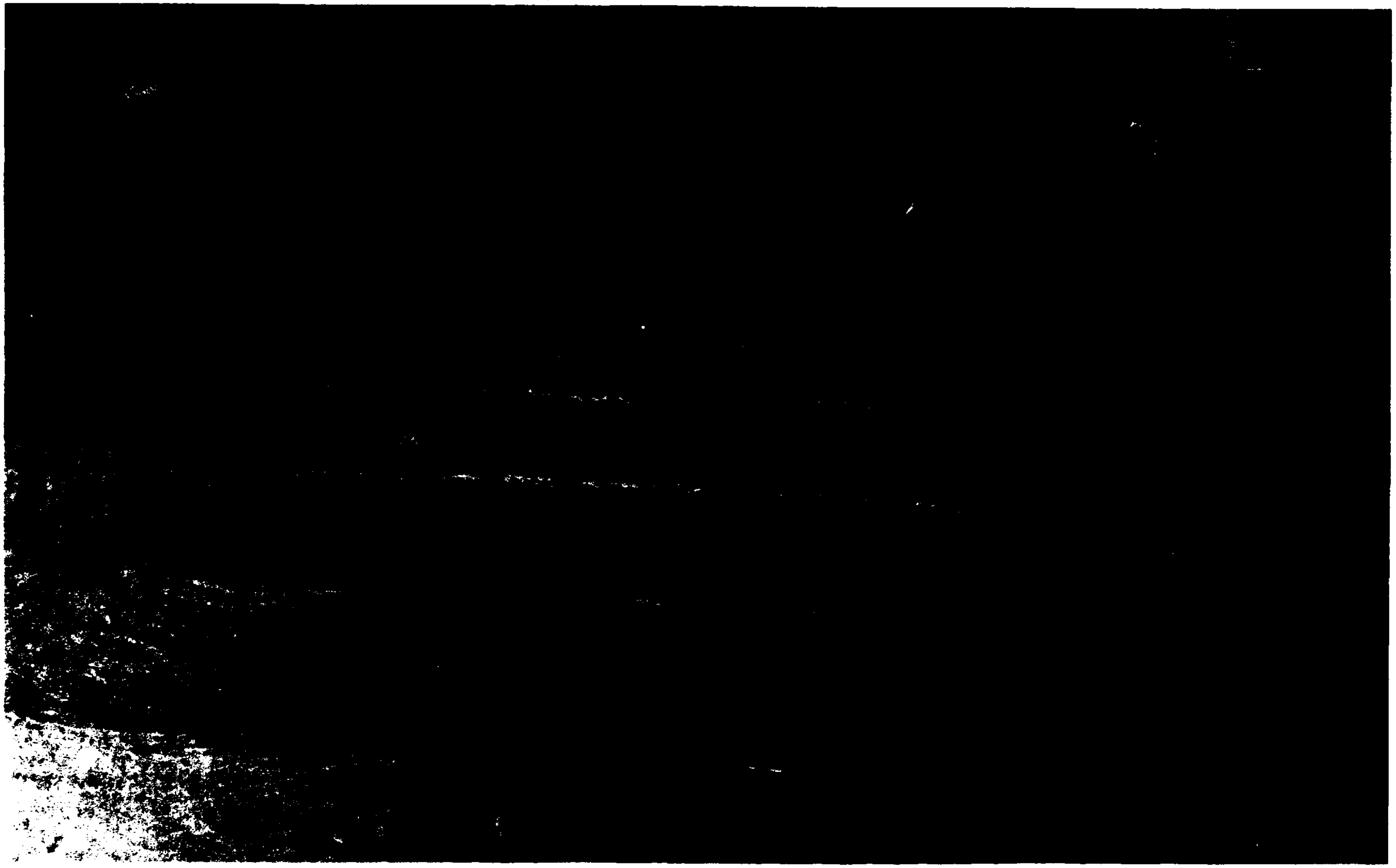


Photo 132. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Base Test 2; 13-sec, 7-ft waves from SSW; swl = +6.7 ft

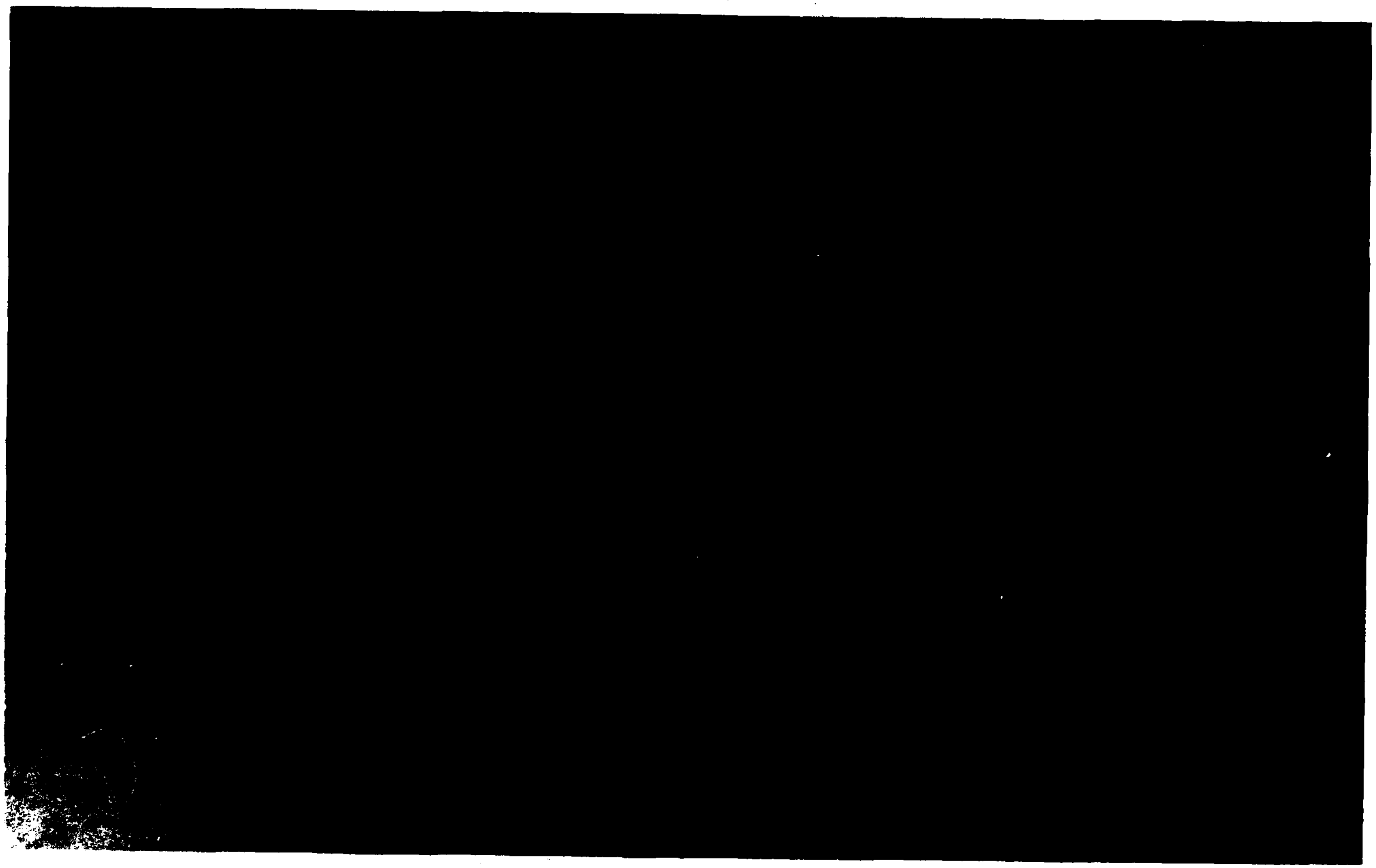


Photo 133. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW with Base Test 2 installed; swl = 0.0 ft

Photo 134. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW with Base Test 2 installed; swl = 0.0 ft

Photo 135. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW with Base Test 2 installed; swl = 0.0 ft

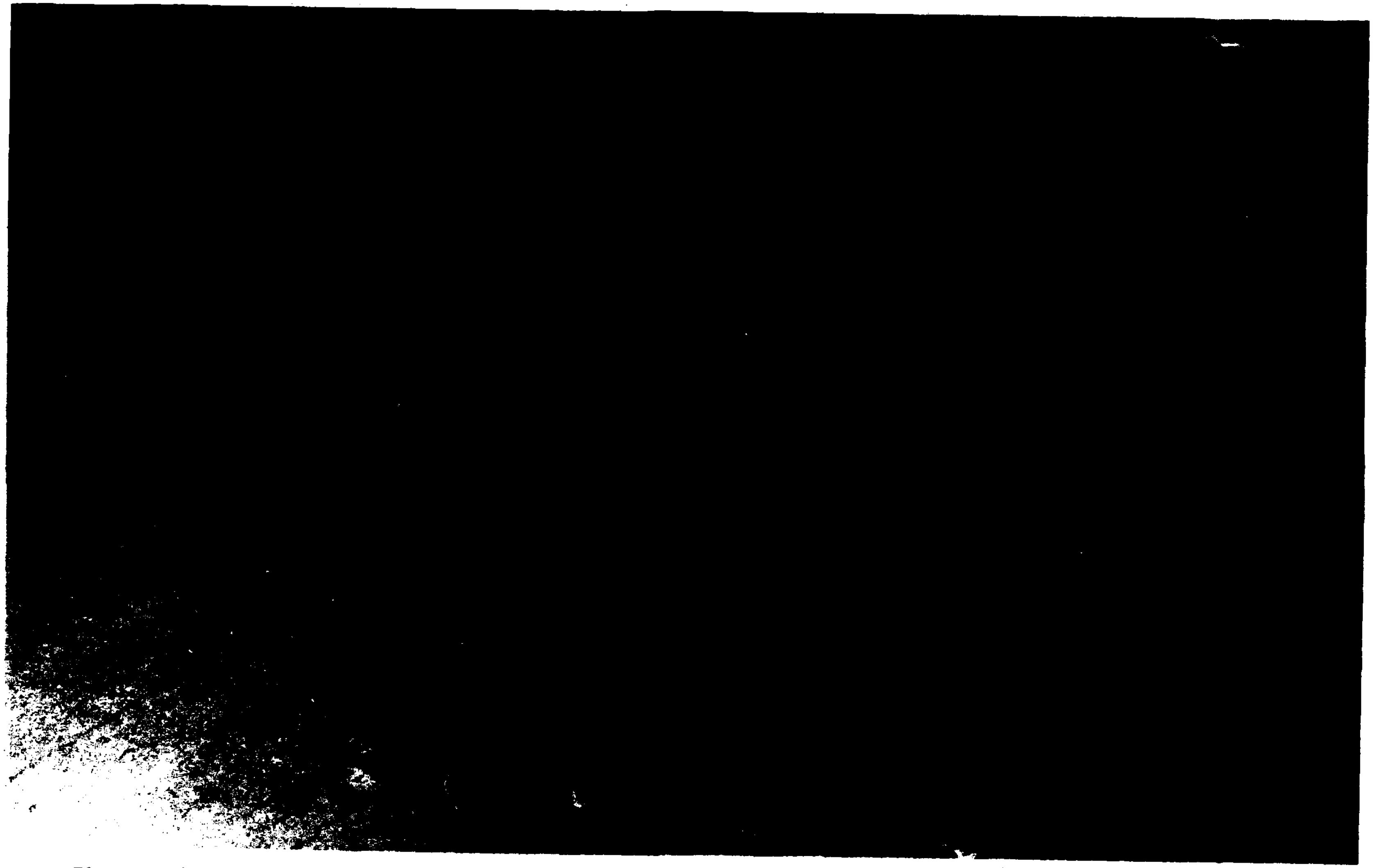


Photo 136. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

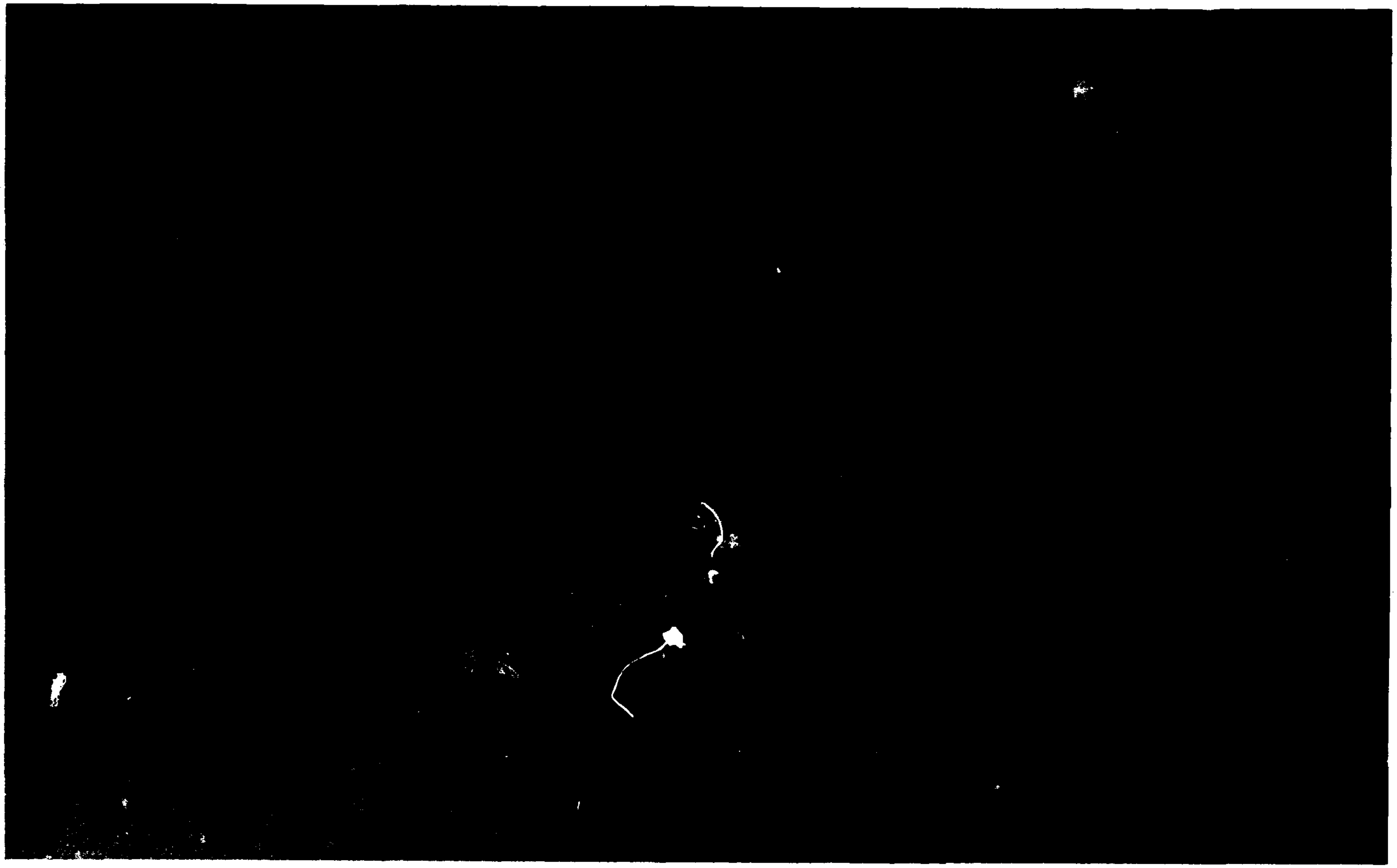


Photo 137. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

Photo 138. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

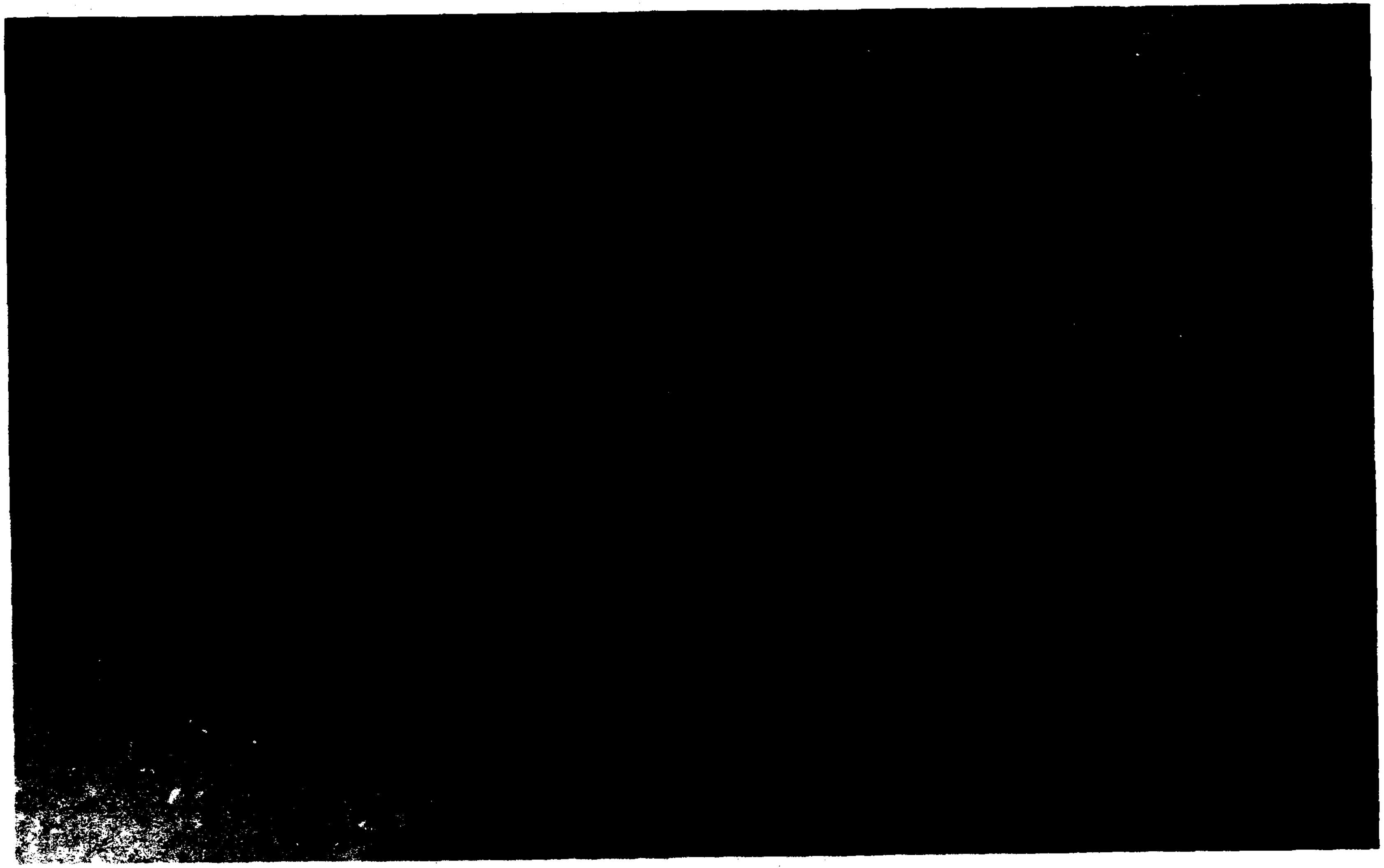


Photo 139. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for maximum flood with Base Test 2 installed; swl = +4.3 ft

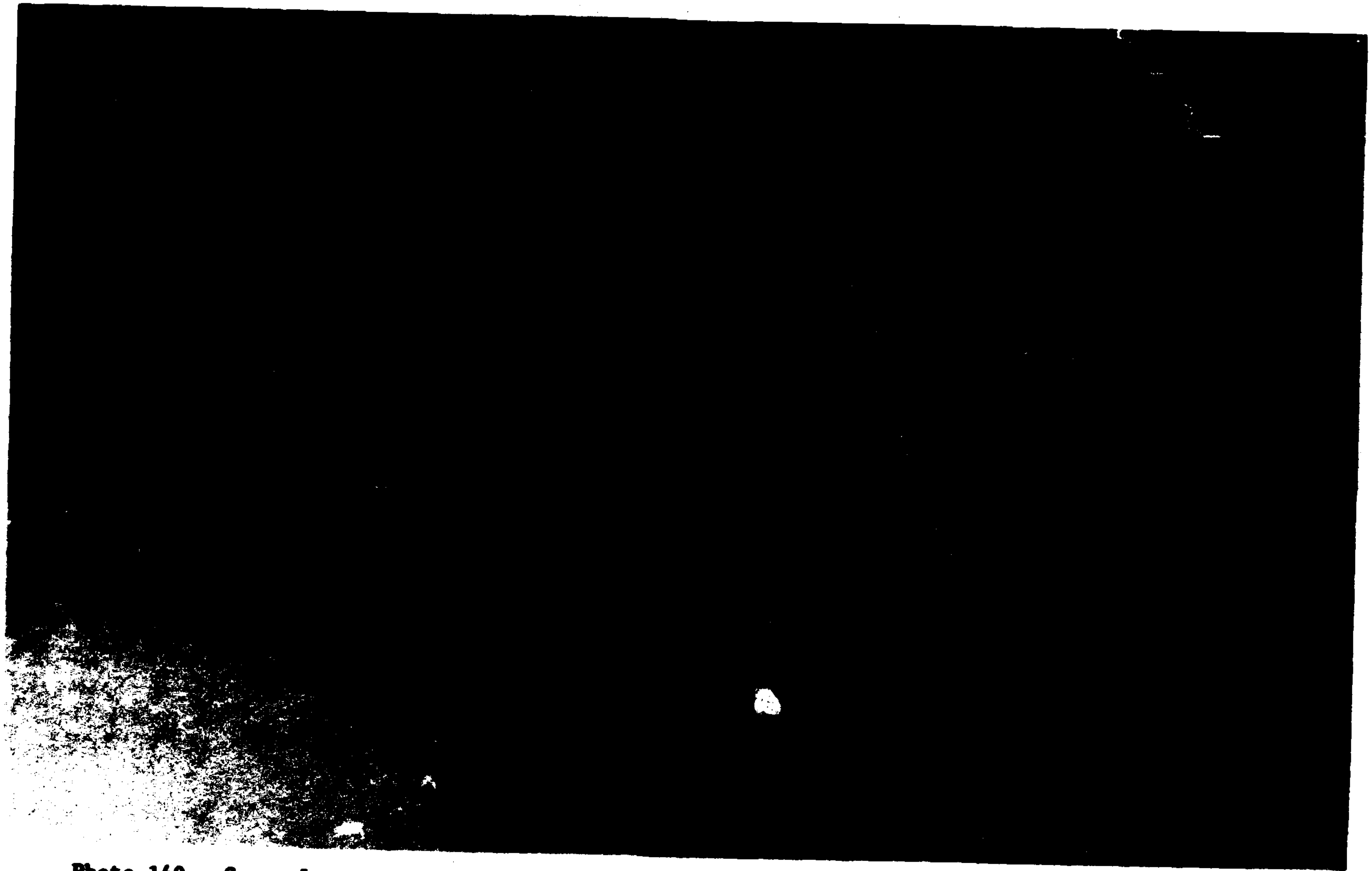


Photo 140. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum flood with Base Test 2 installed; swl = +4.3 ft

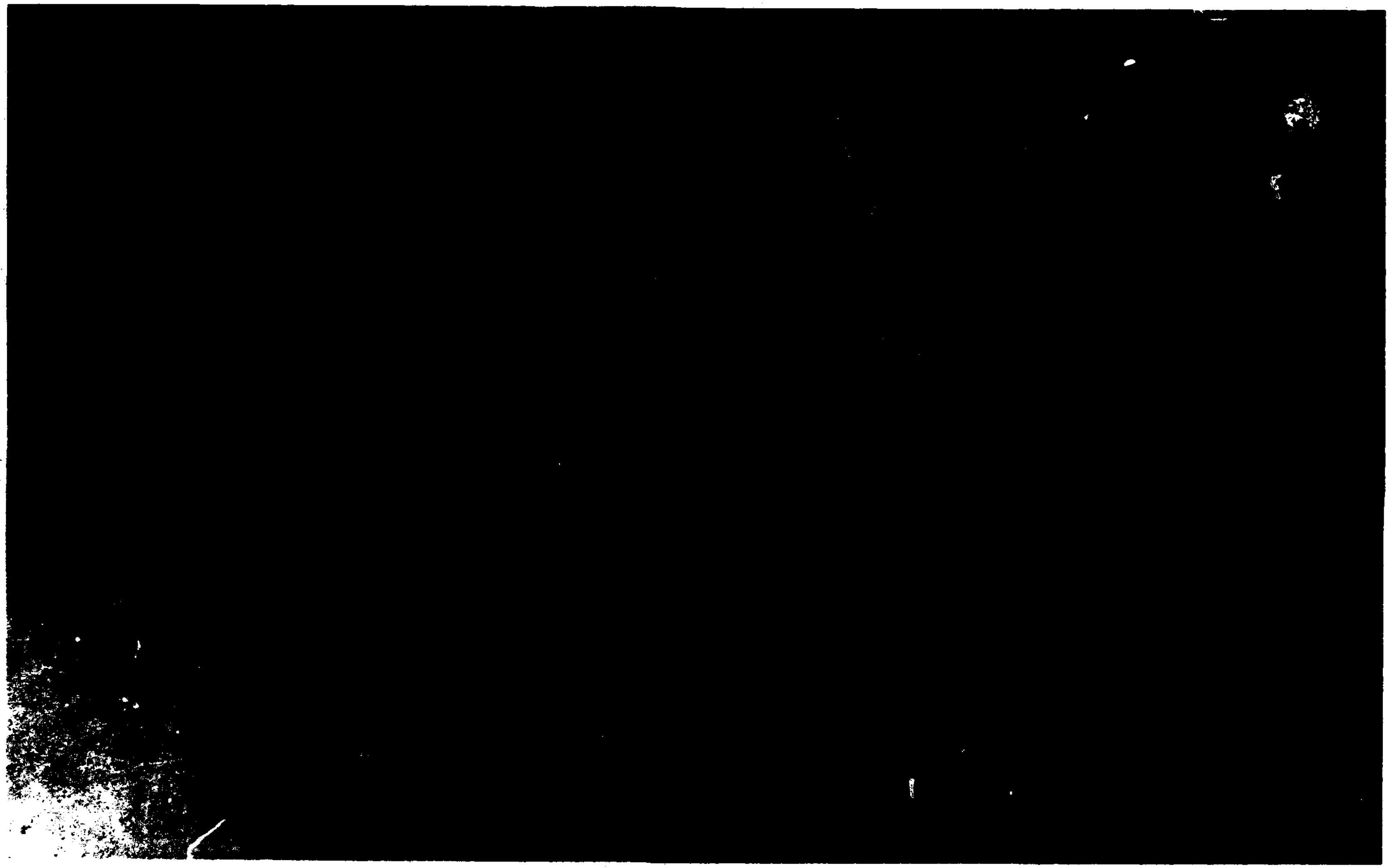


Photo 141. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for maximum flood with Base Test 2 installed; swl = +4.3 ft

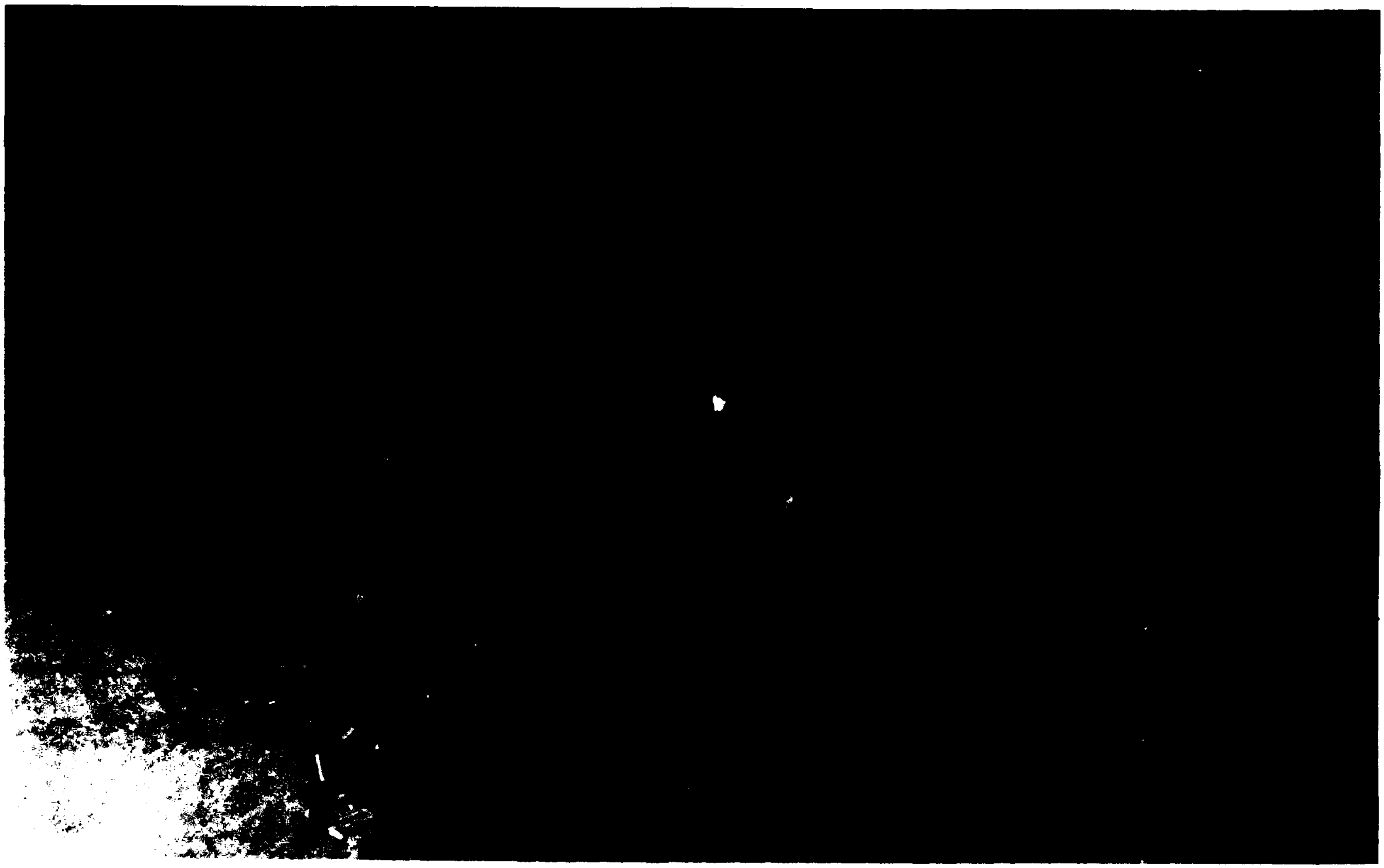


Photo 142. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW with Base Test 2 installed; swl = +6.7 ft

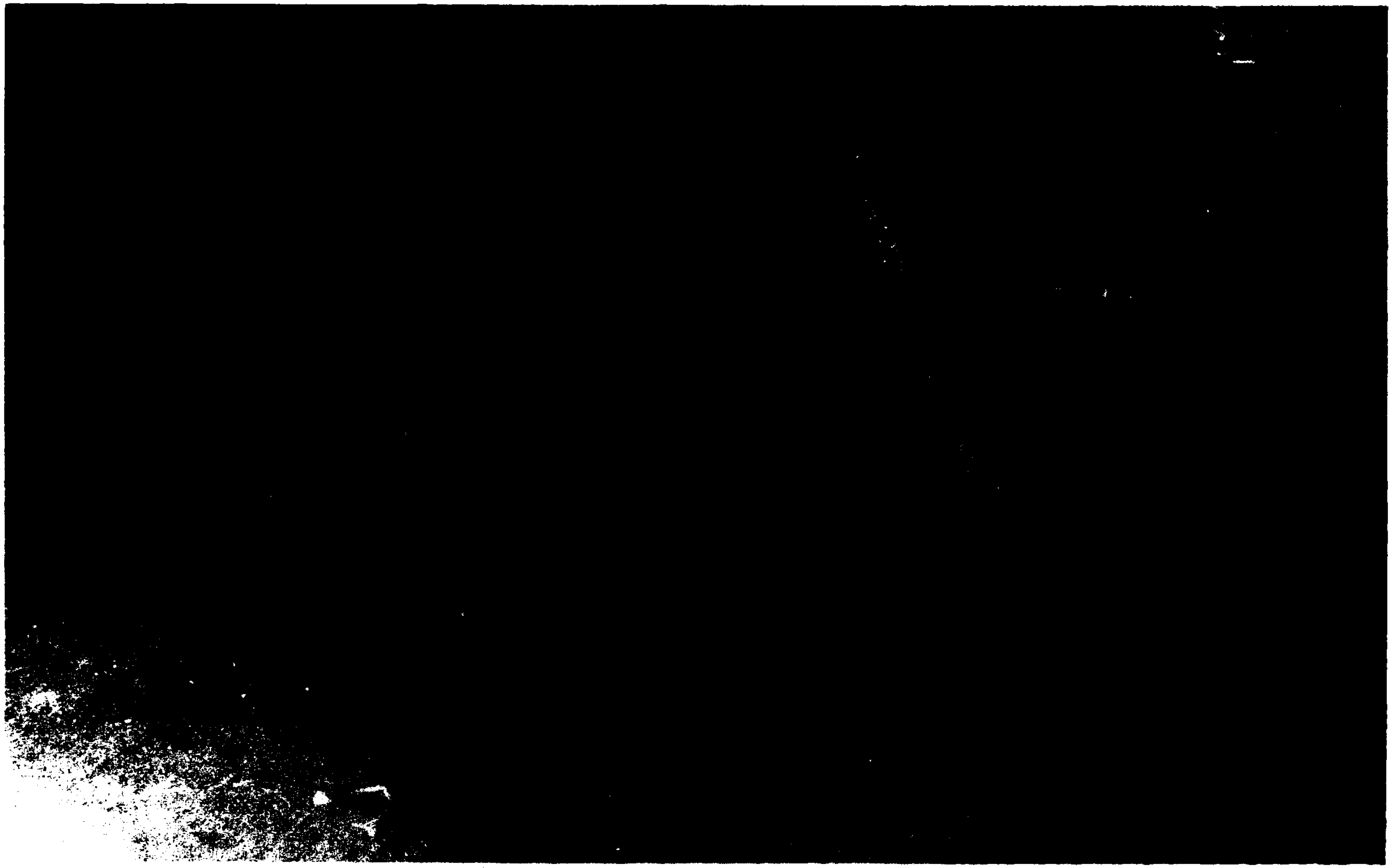


Photo 143. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW with Base Test 2 installed; swl = +6.7 ft

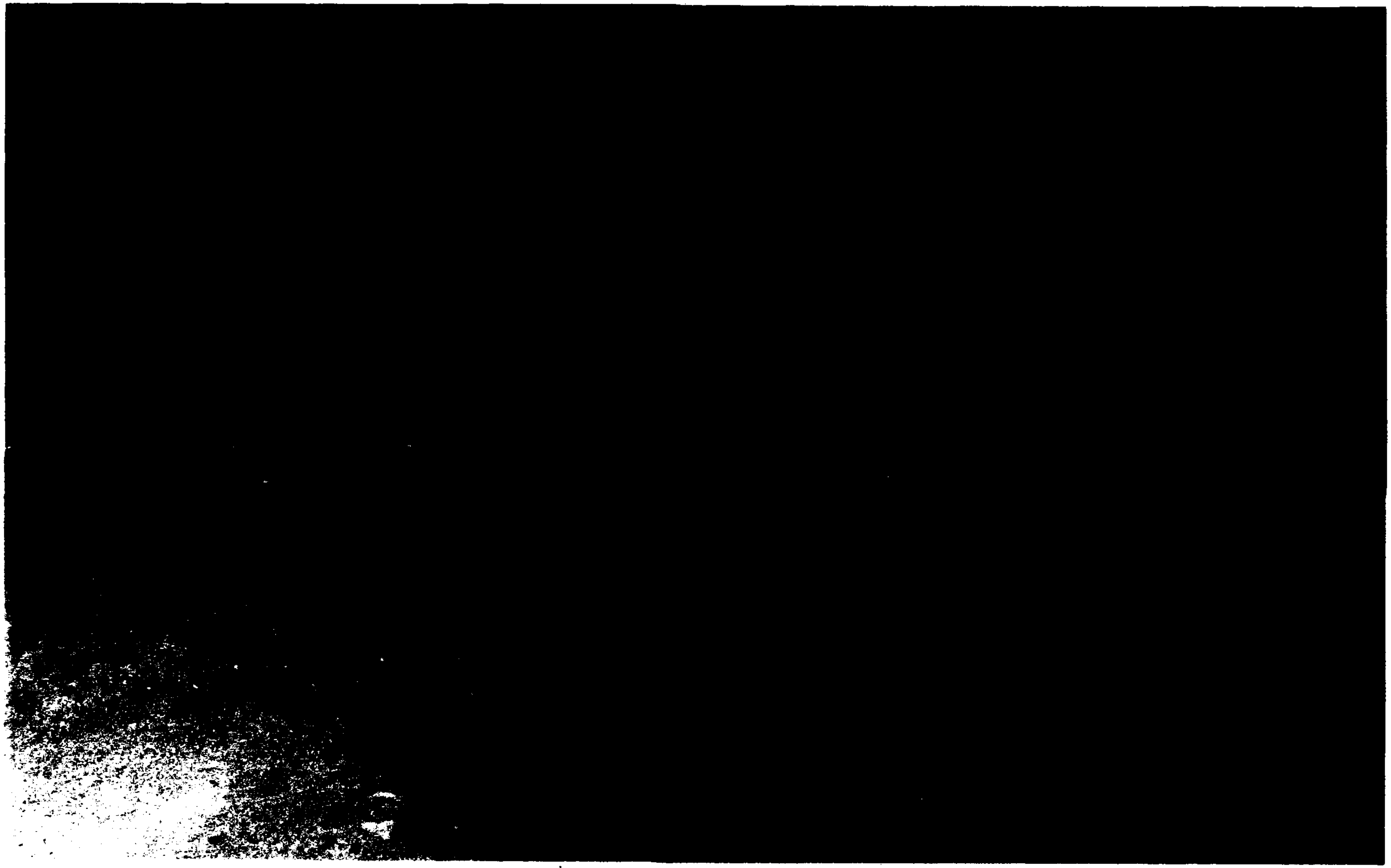


Photo 144. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW with Base Test 2 installed; swl = +6.7 ft

Photo 145. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west with Base Test 2 installed; swl = 0.0 ft

Photo 146. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west with Base Test 2 installed; swl = 0.0 ft

Photo 147. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west with Base Test 2 installed; swl = 0.0 ft

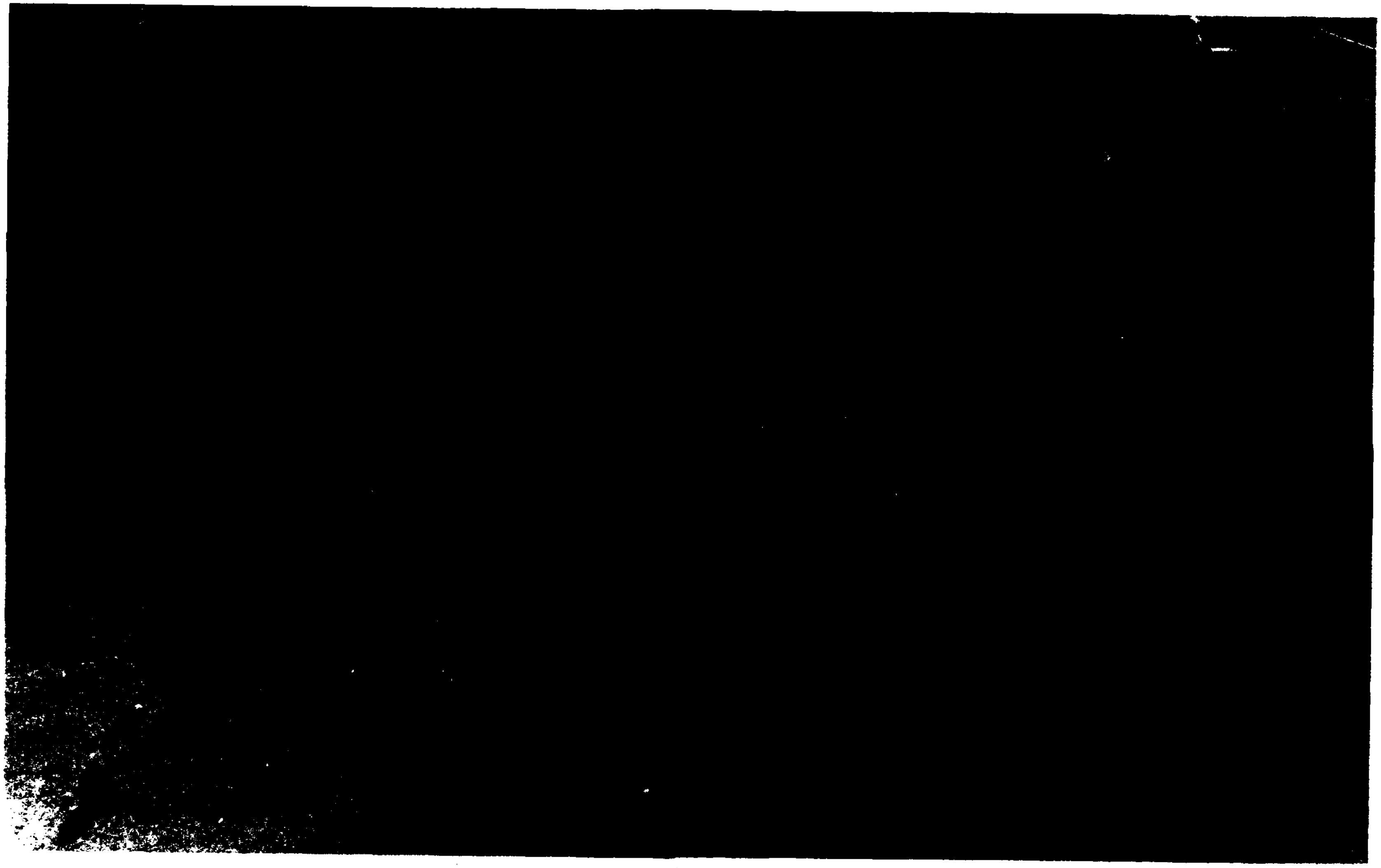


Photo 148. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for maximum ebb with Base Test 2 installed; swl = +1.5 ft

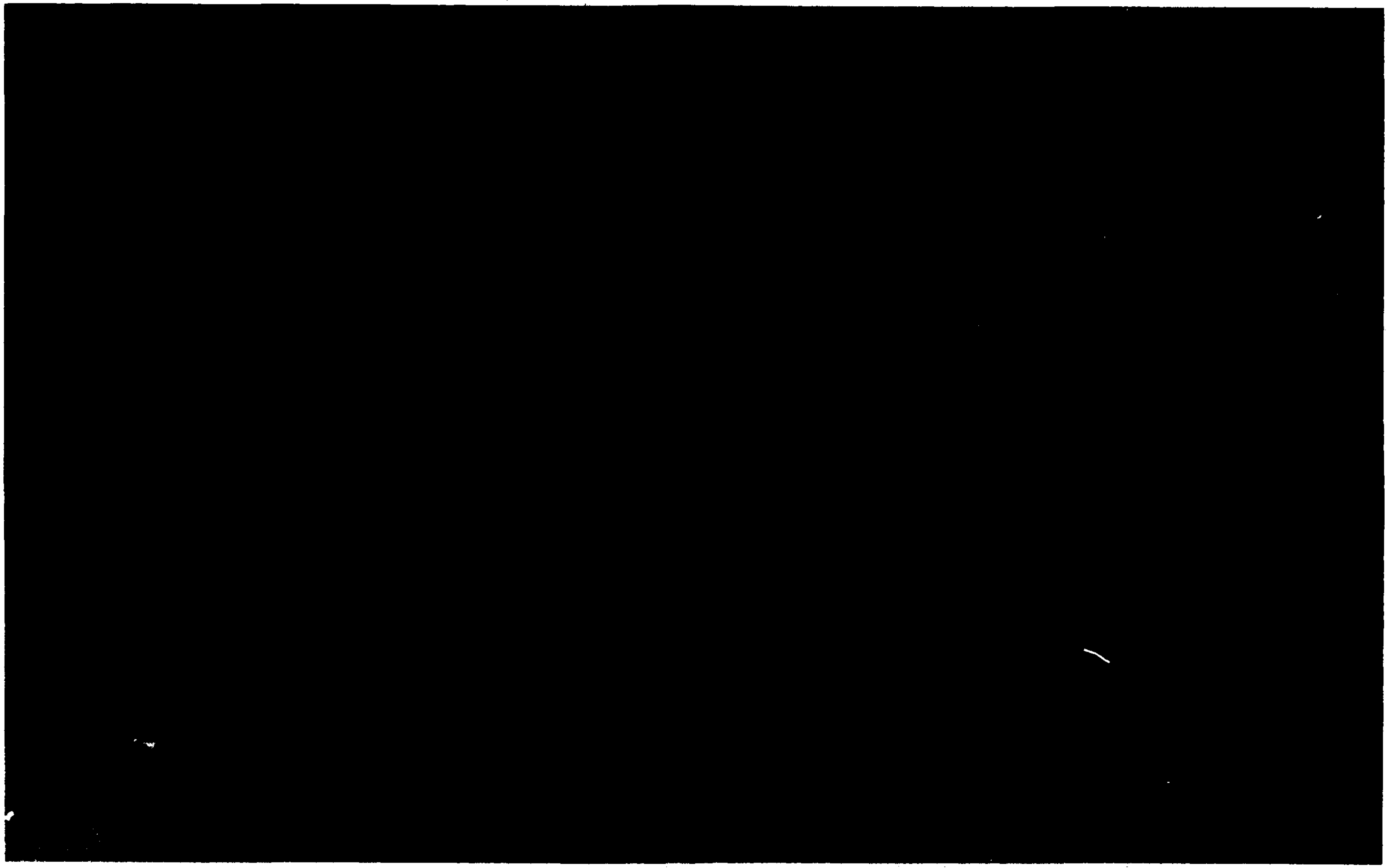


Photo 149. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum ebb with Base Test 2 installed; swl = +1.5 ft

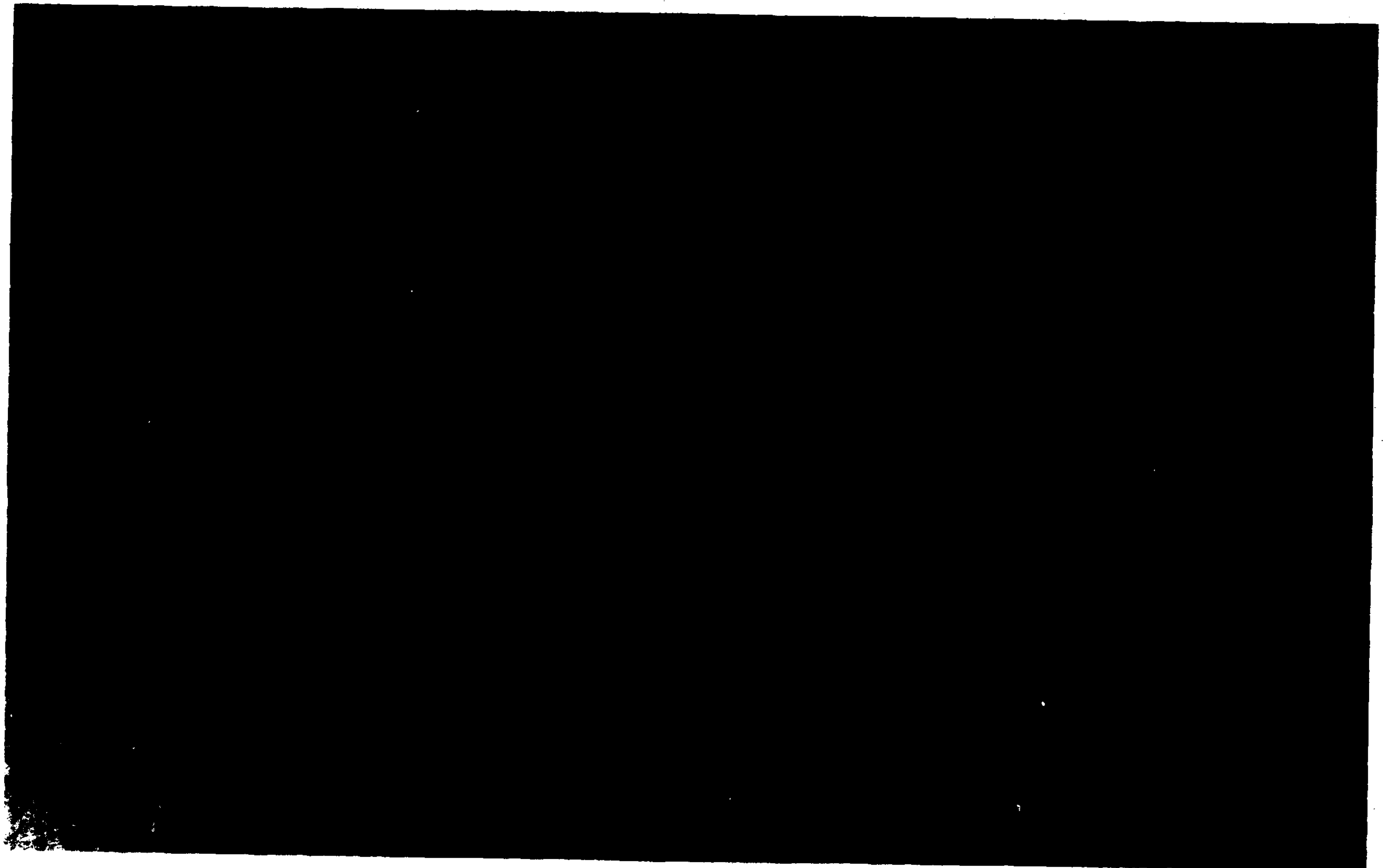


Photo 150. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for maximum ebb with Base Test 2 installed; swl = +1.5 ft

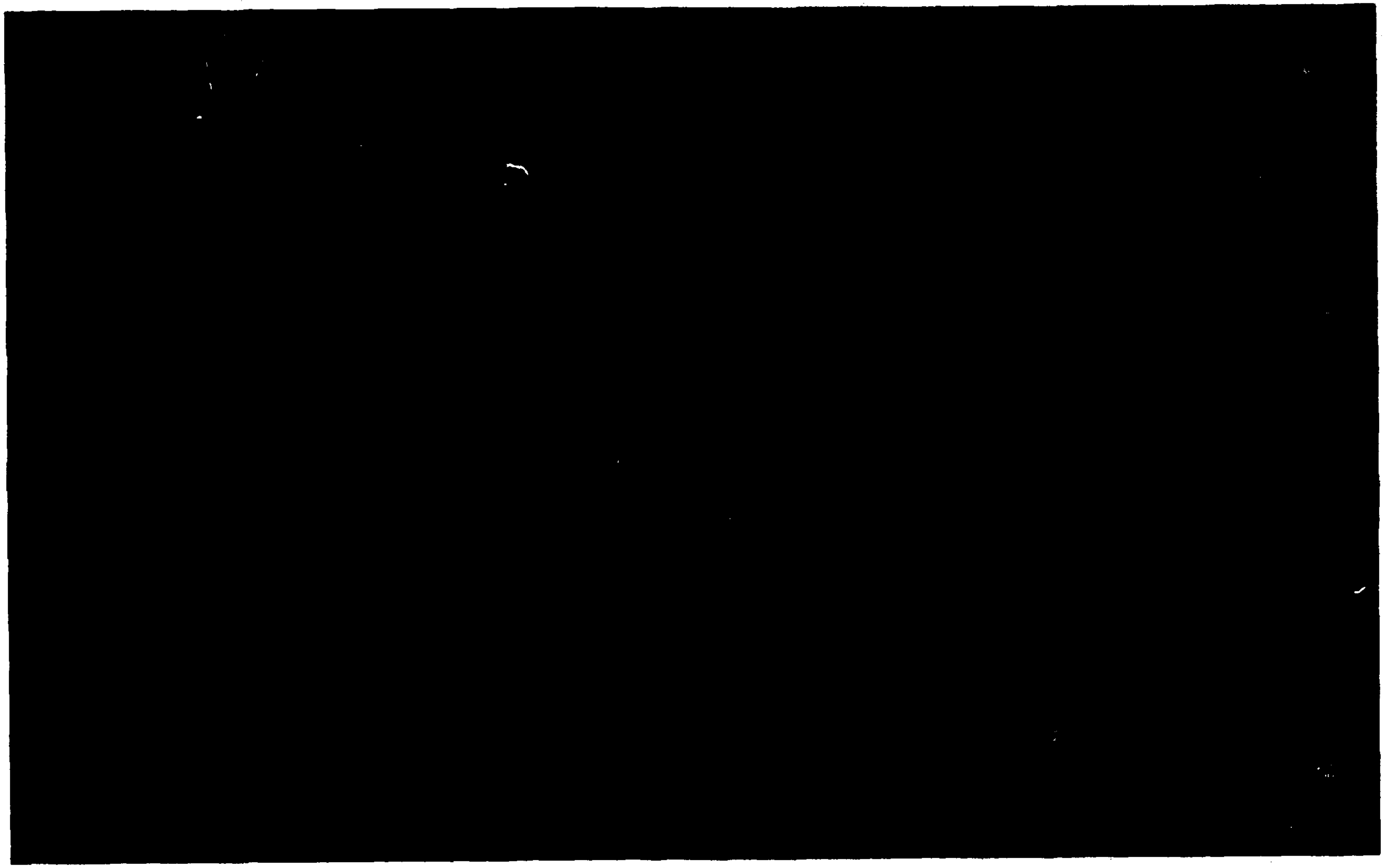


Photo 151. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for maximum flood with Base Test 2 installed; swl = +4.3 ft

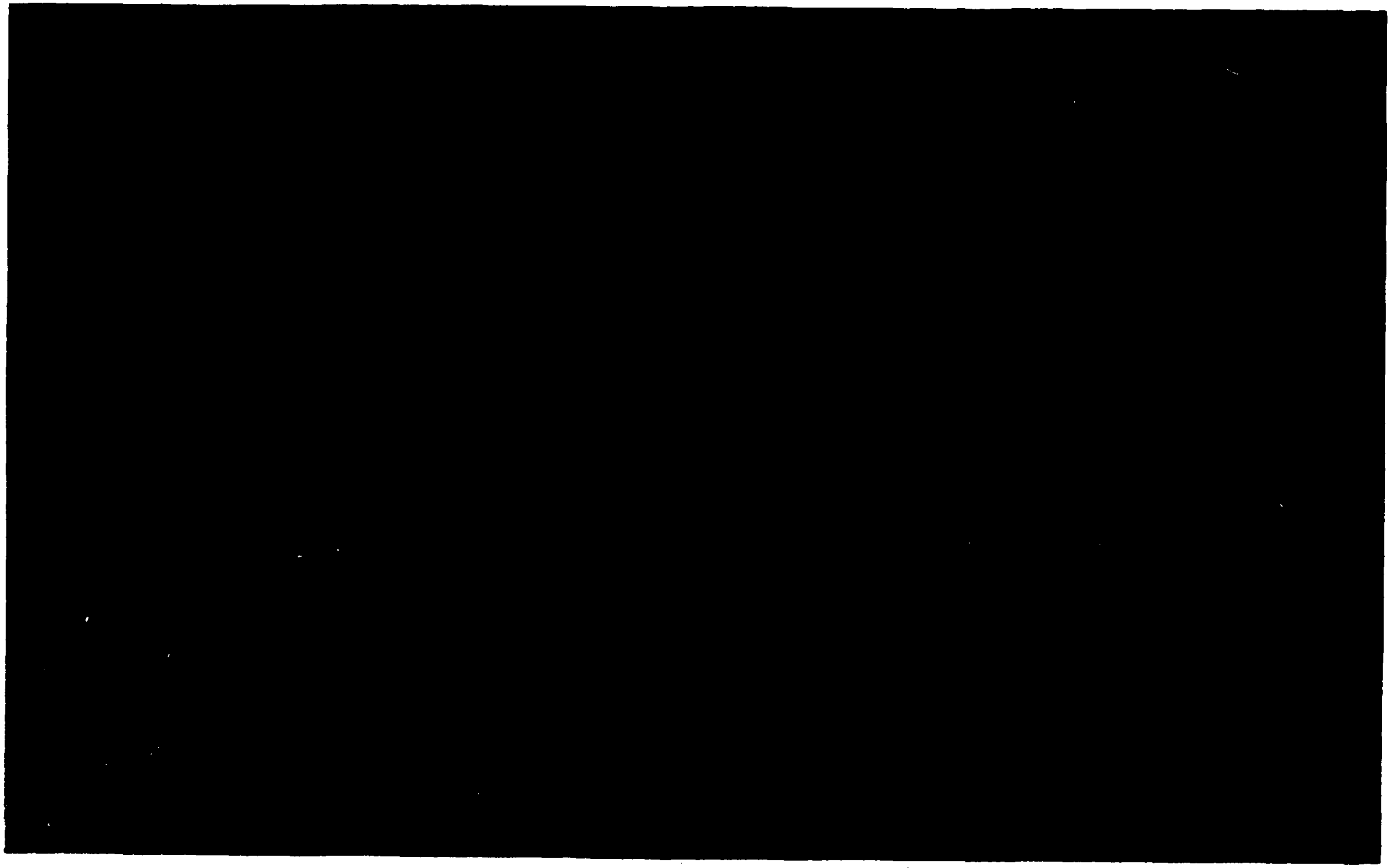


Photo 152. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum flood with Base Test 2 installed; swl = +4.3 ft

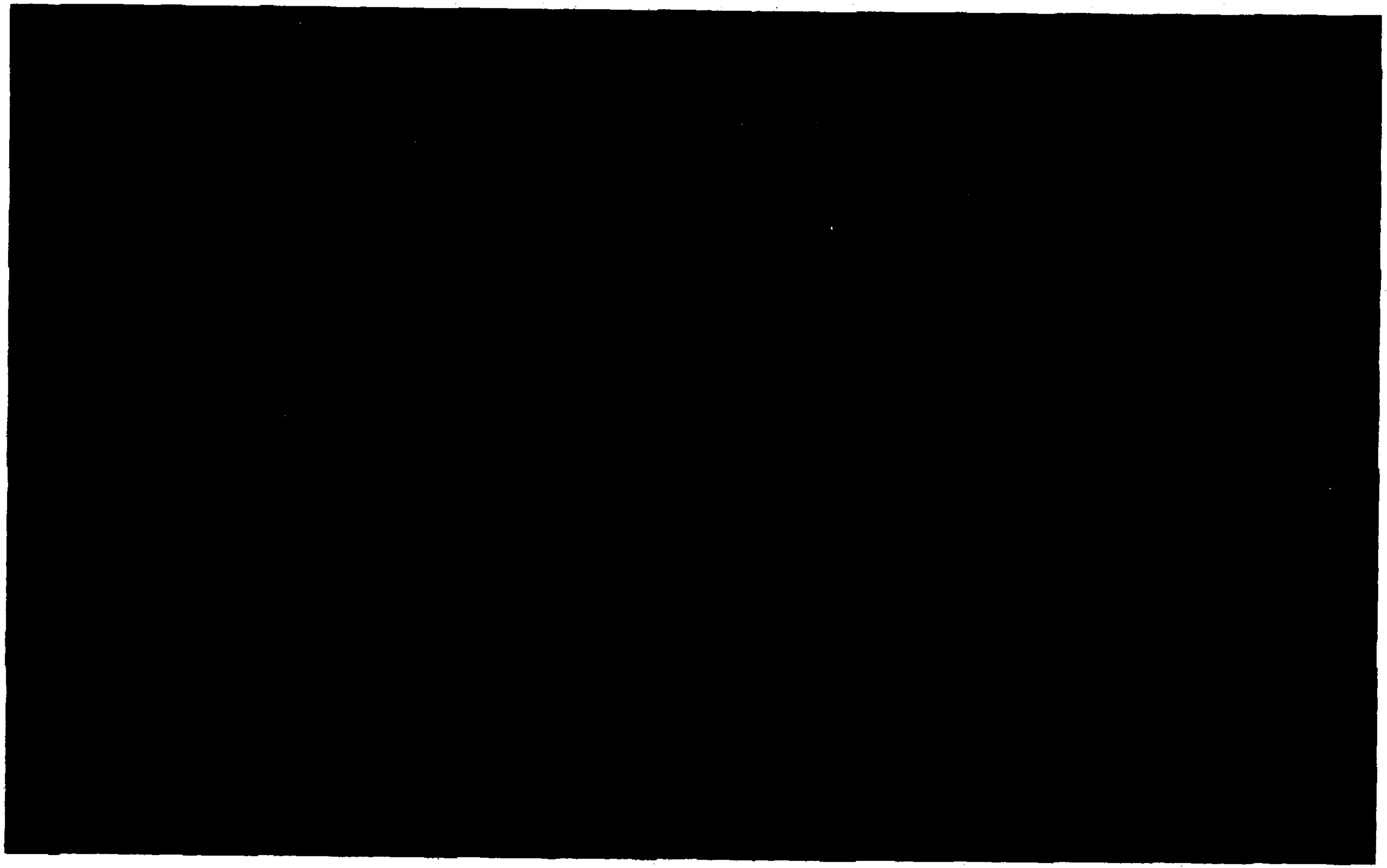


Photo 153. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for maximum flood with Base Test 2 installed; swl = +4.3 ft

Photo 154. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west with Base Test 2 installed; swl = +6.7 ft

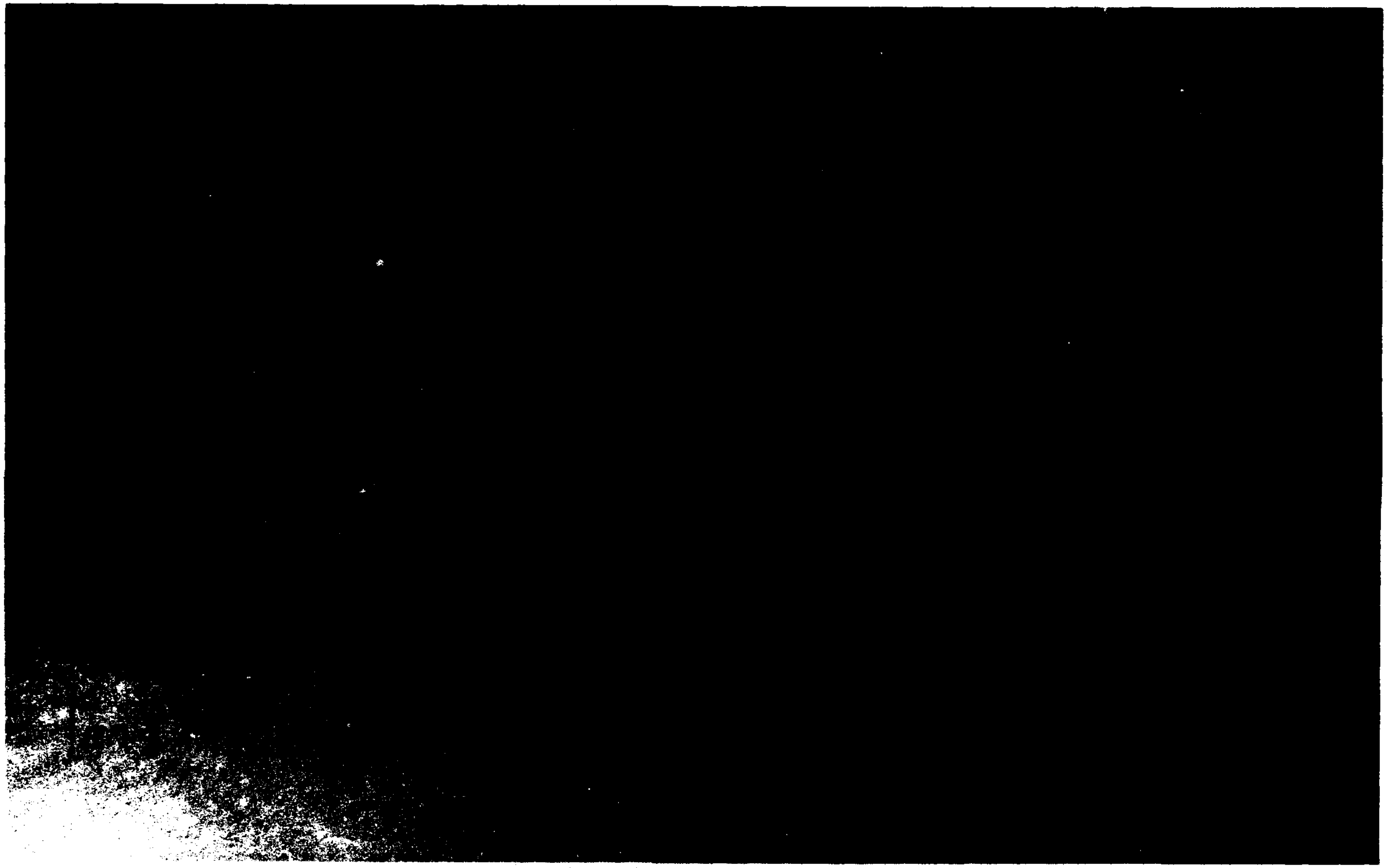


Photo 155. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west with Base Test 2 installed; swl = +6.7 ft

Photo 156. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west with Base Test 2 installed; swl = +6.7 ft

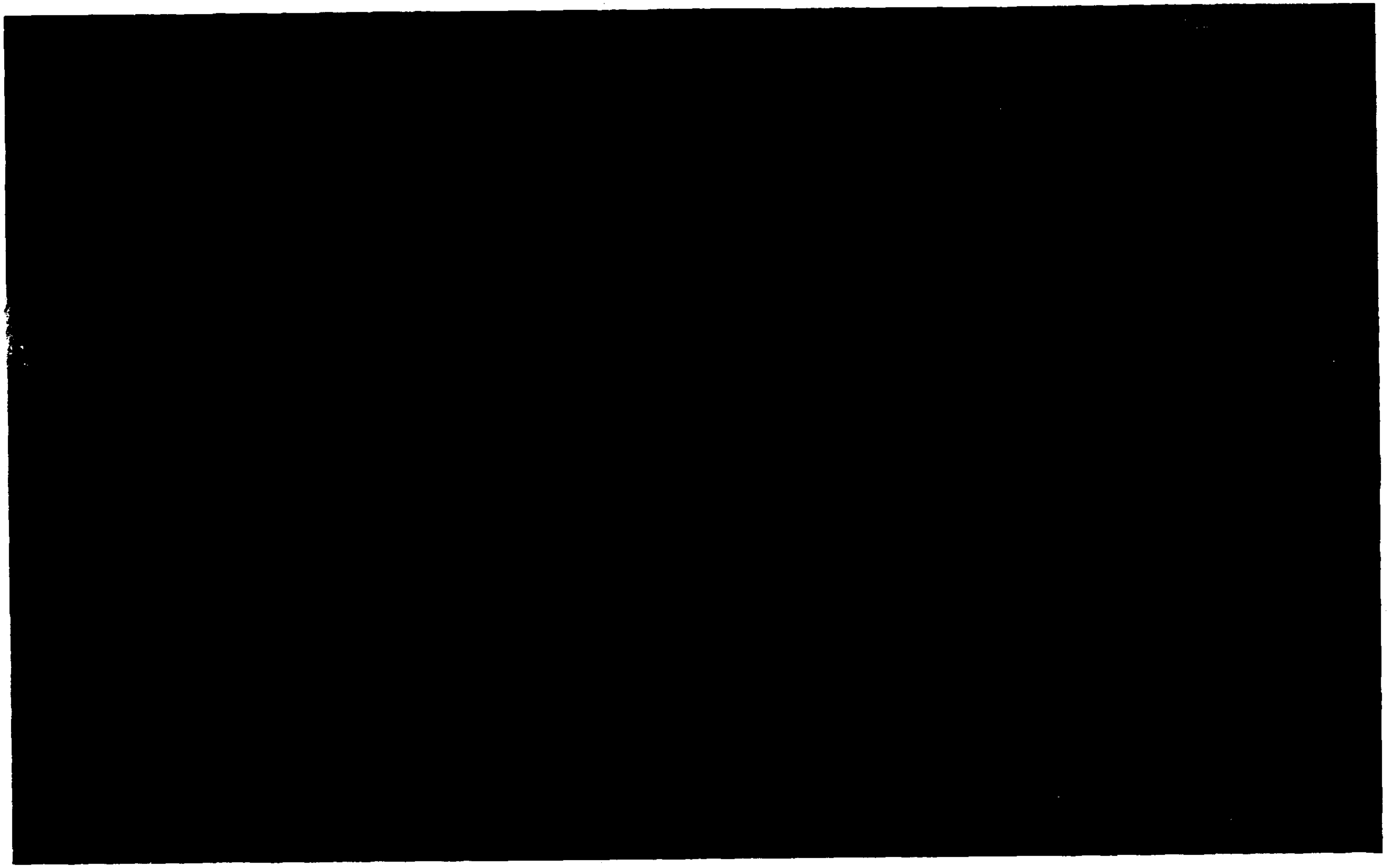


Photo 157. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW with Base Test 2 installed; swl = 0.0 ft

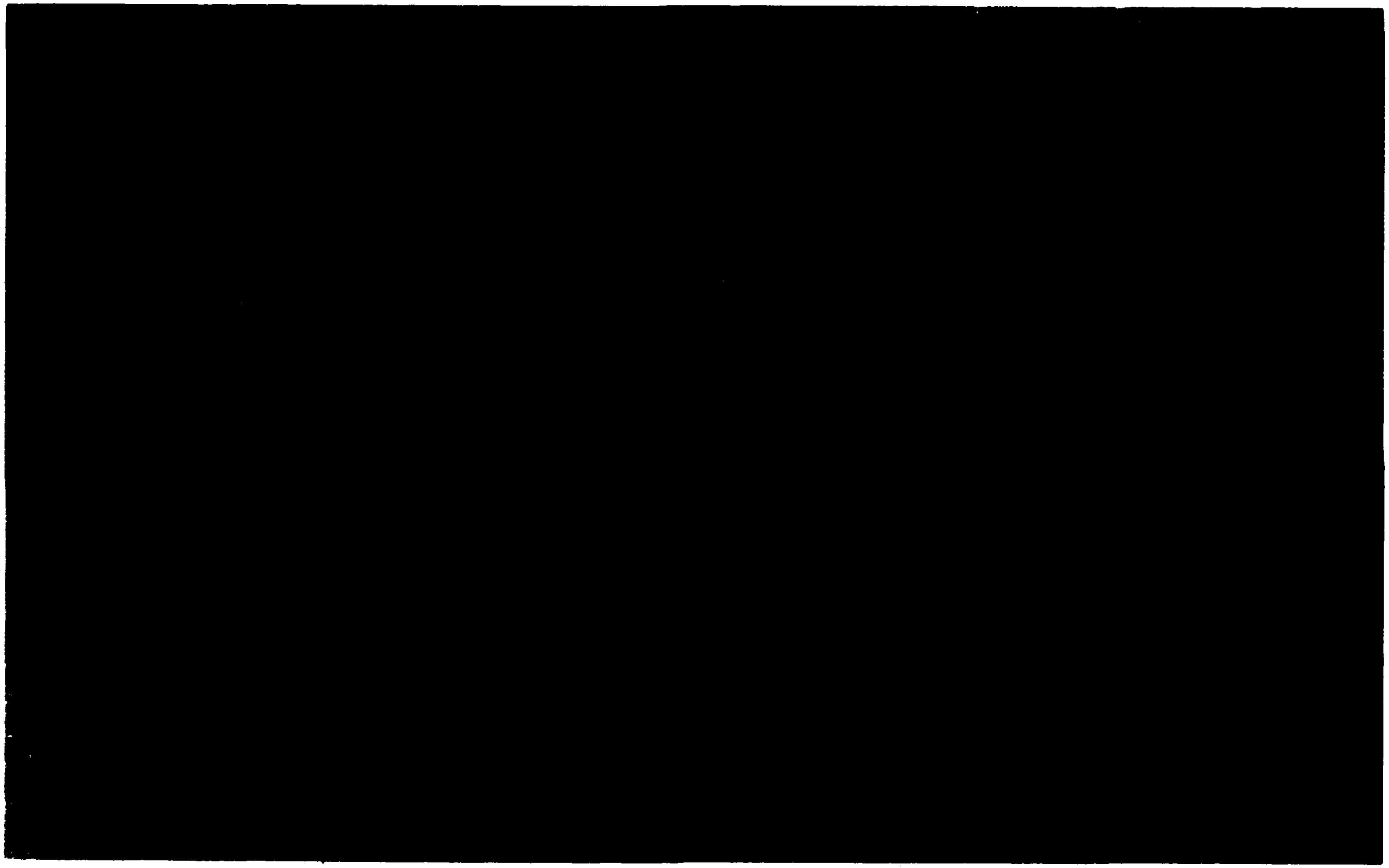


Photo 158. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW with Base Test 2 installed; swl = 0.0 ft

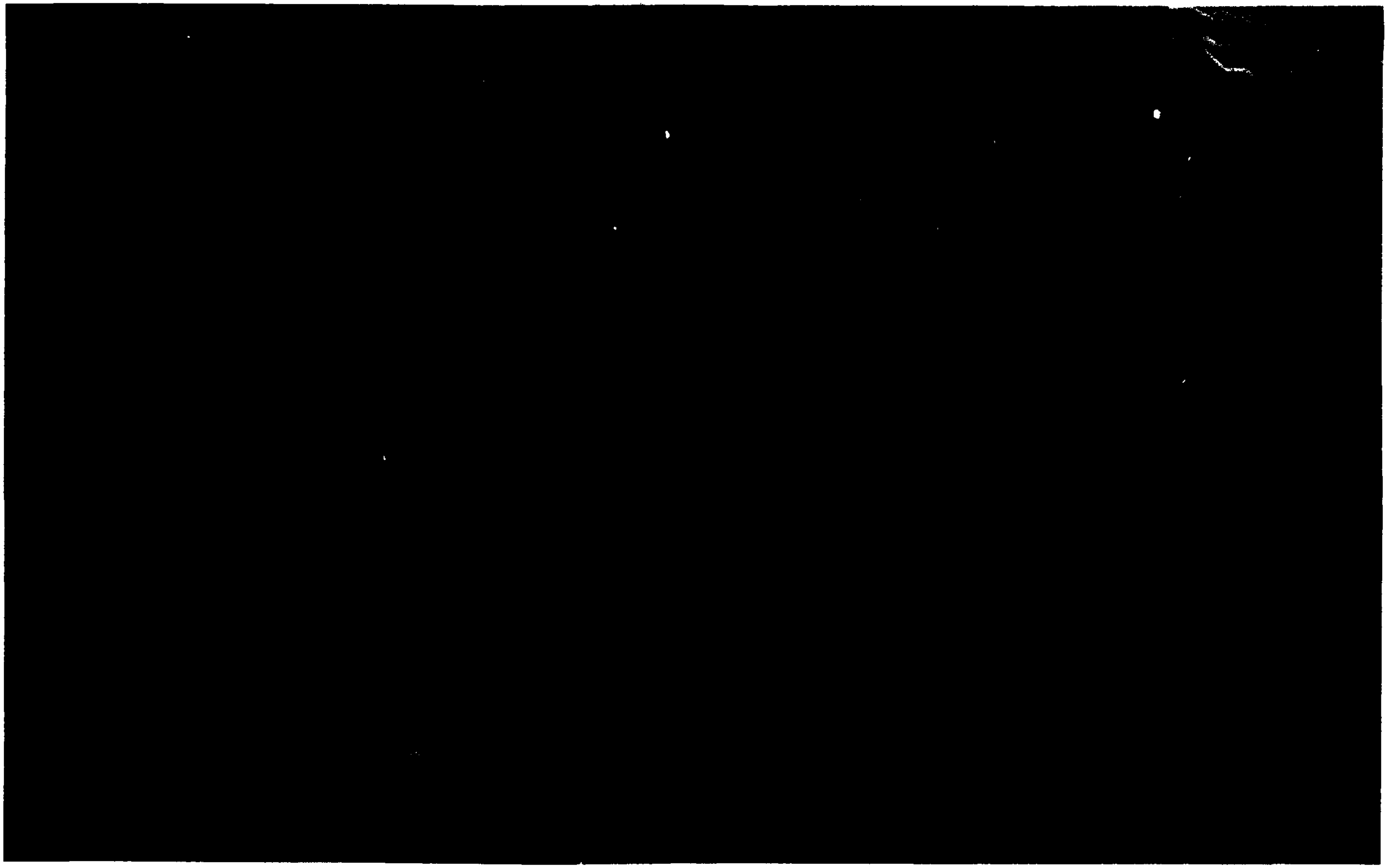


Photo 159. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW with Base Test 2 installed; swl = 0.0 ft

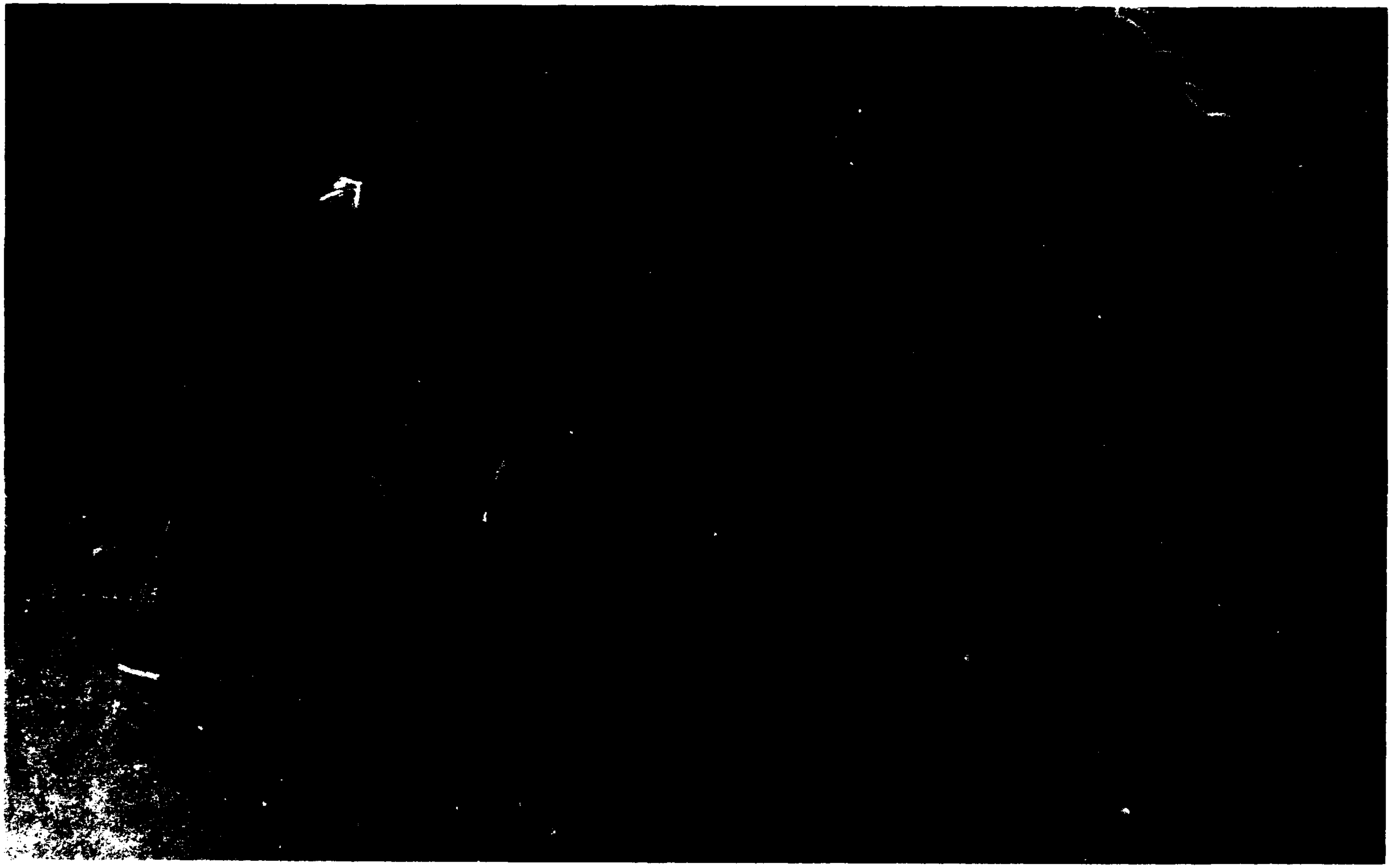


Photo 160. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

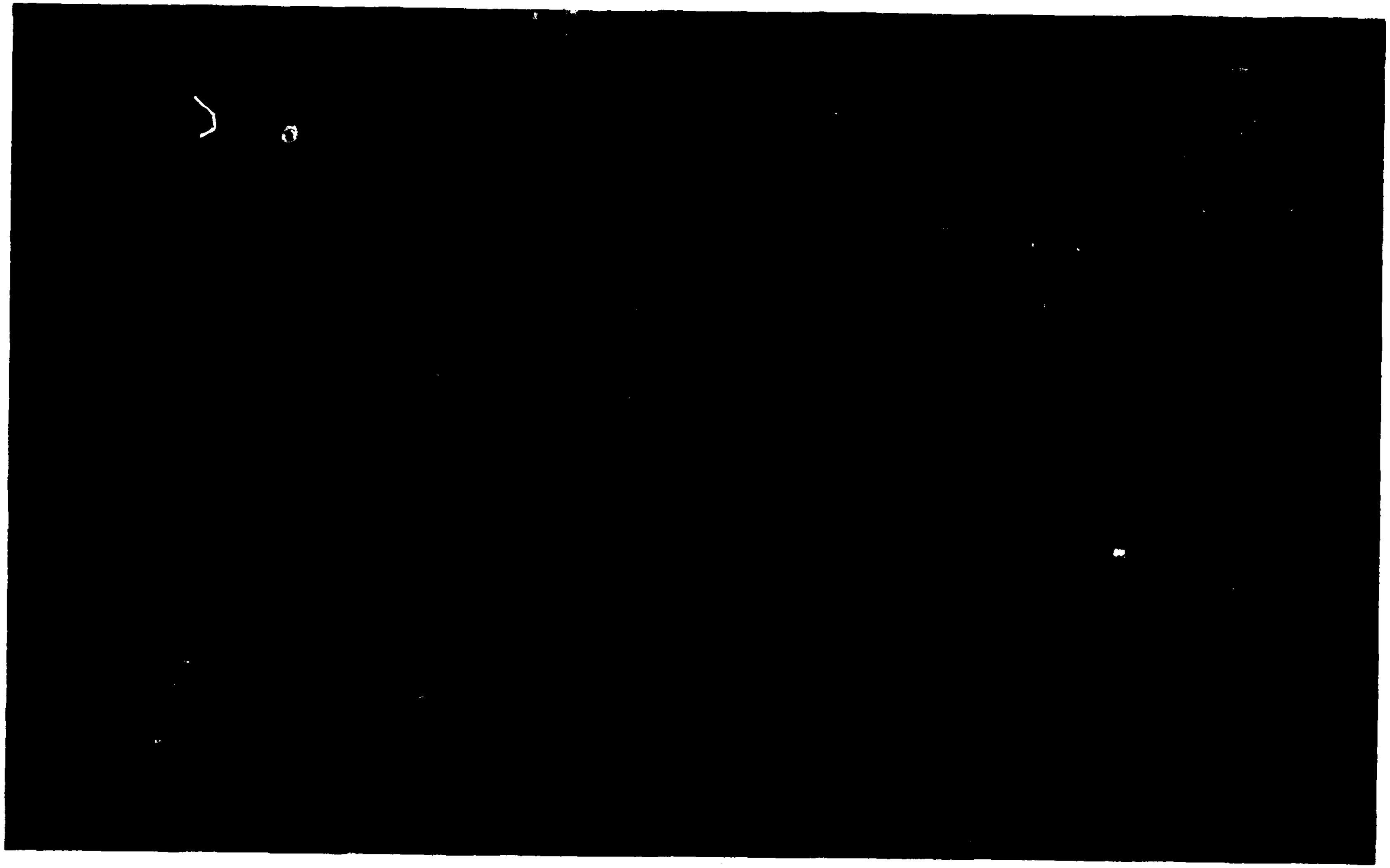


Photo 161. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

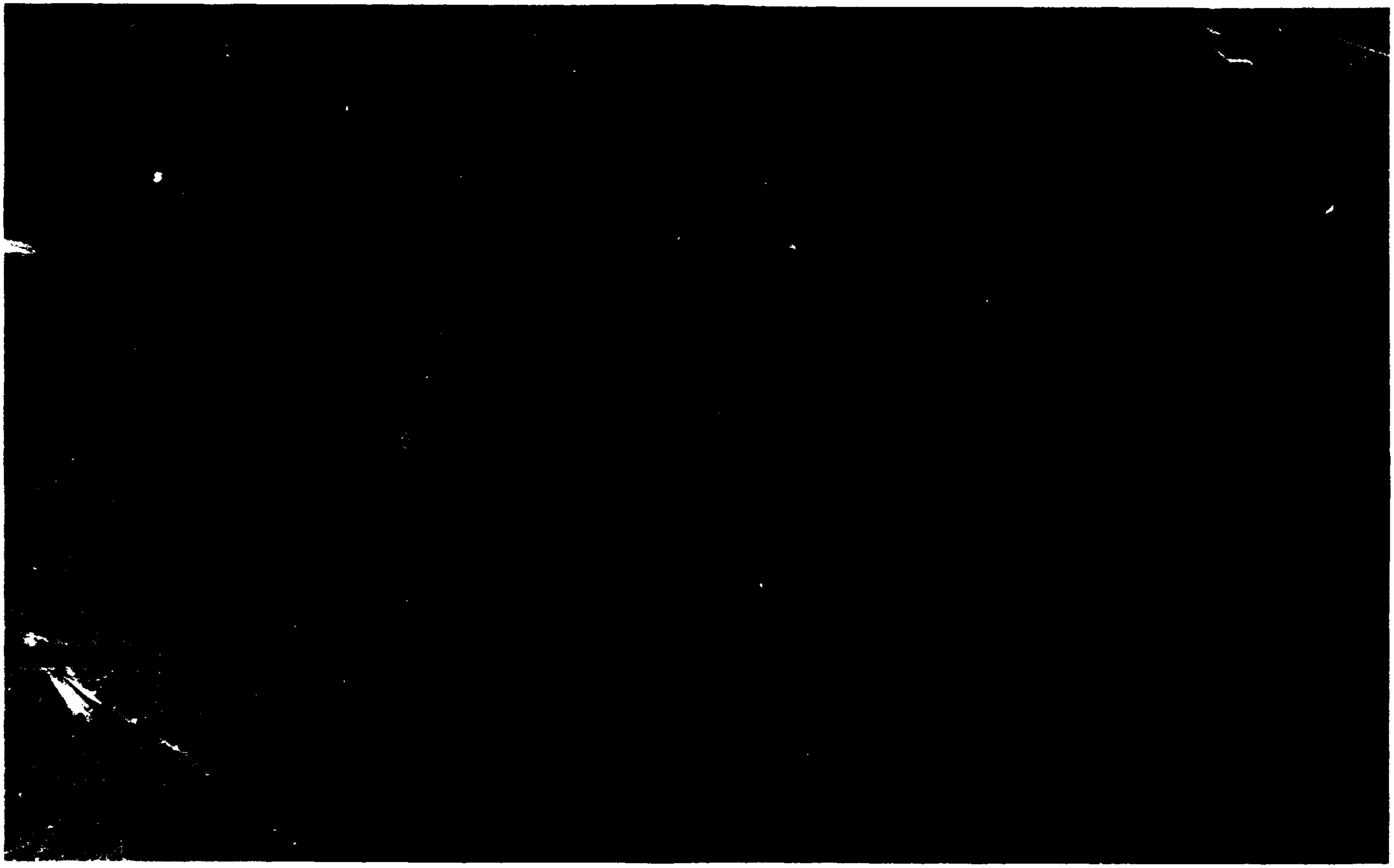


Photo 162. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

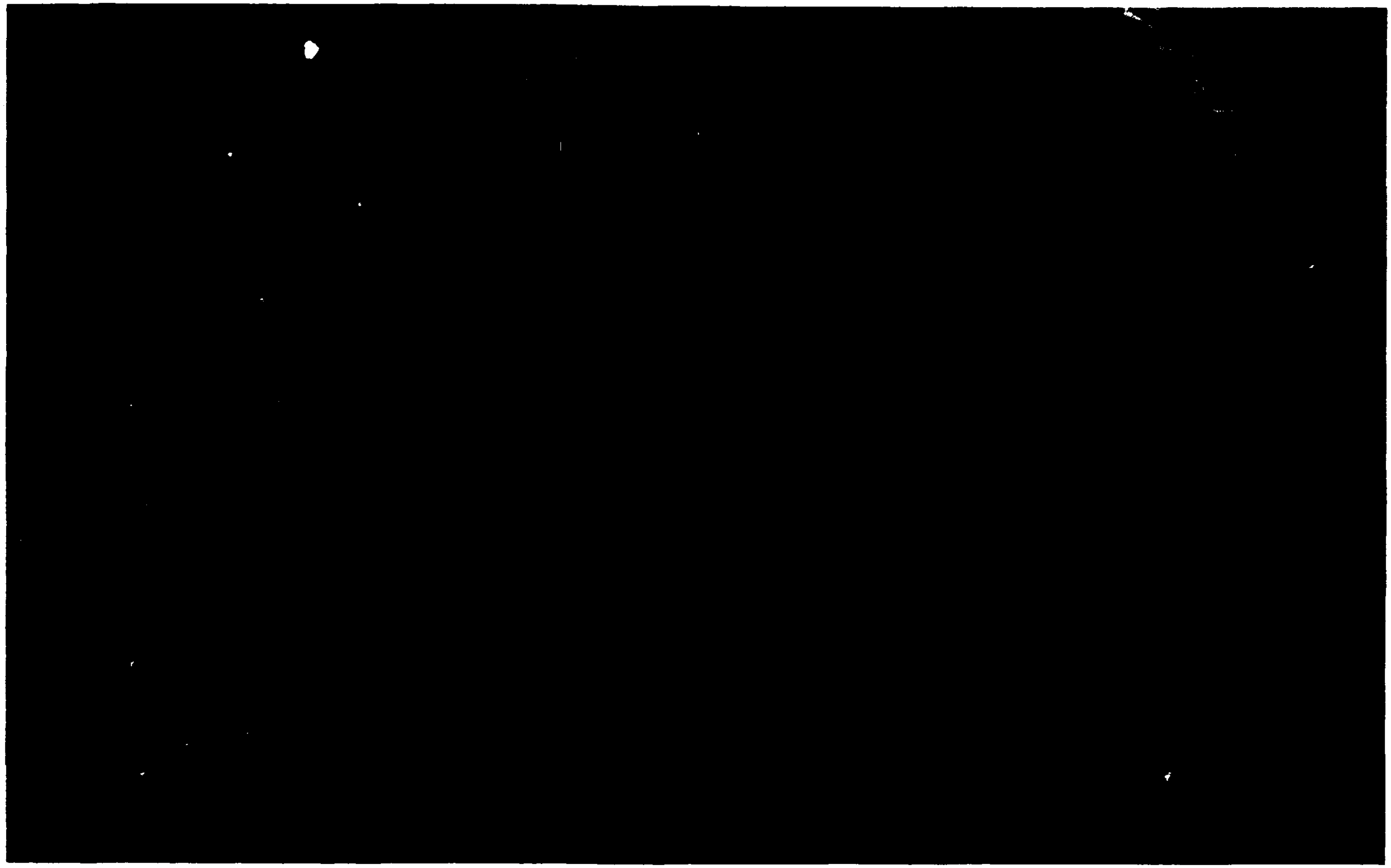


Photo 163. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for maximum flood with Base Test 2 installed; swl = +4.3 ft

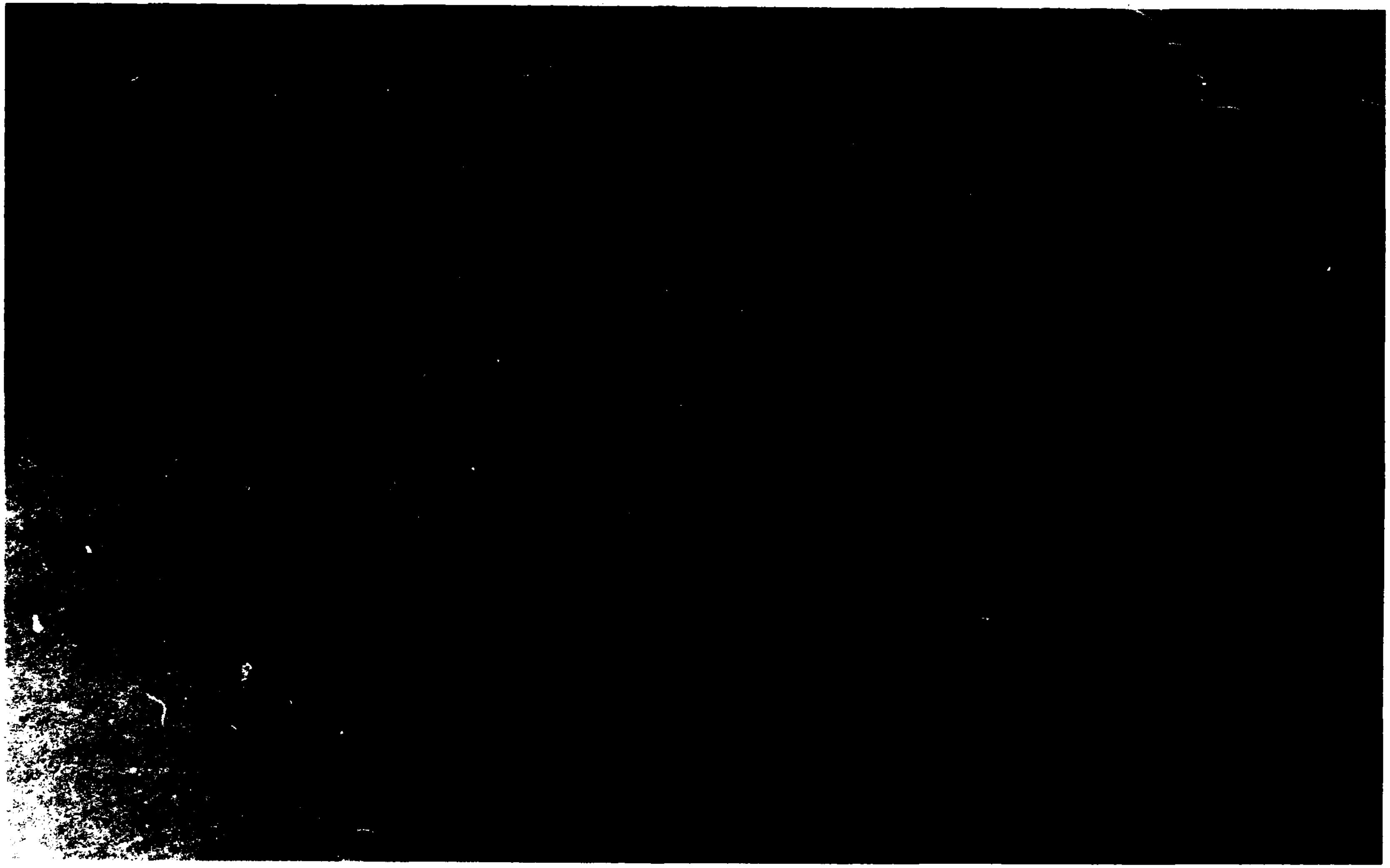


Photo 164. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum flood with Base Test 2 installed; swl = +4.3 ft

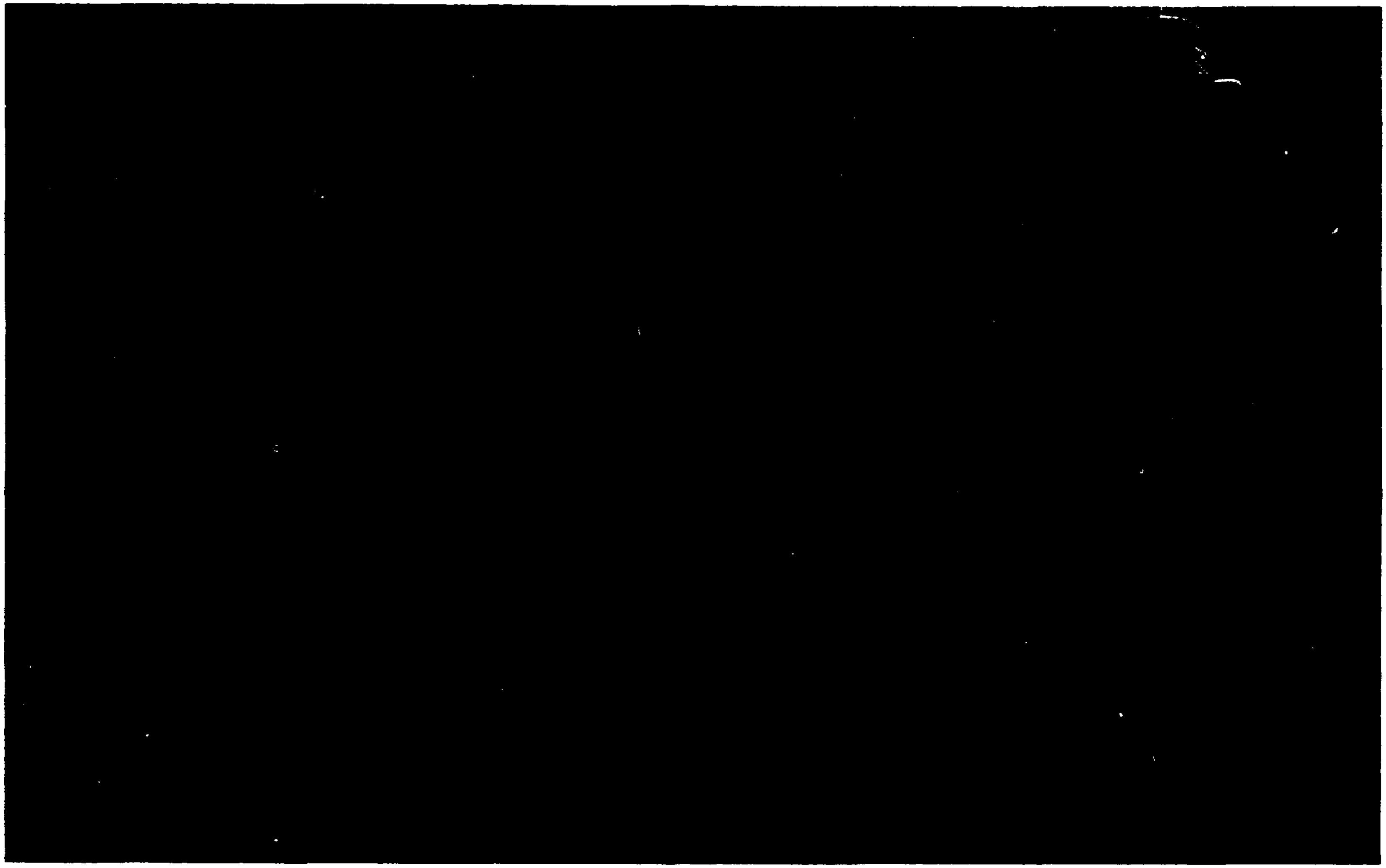


Photo 165. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for maximum flood with Base Test 2 installed; swl = +4.3 ft

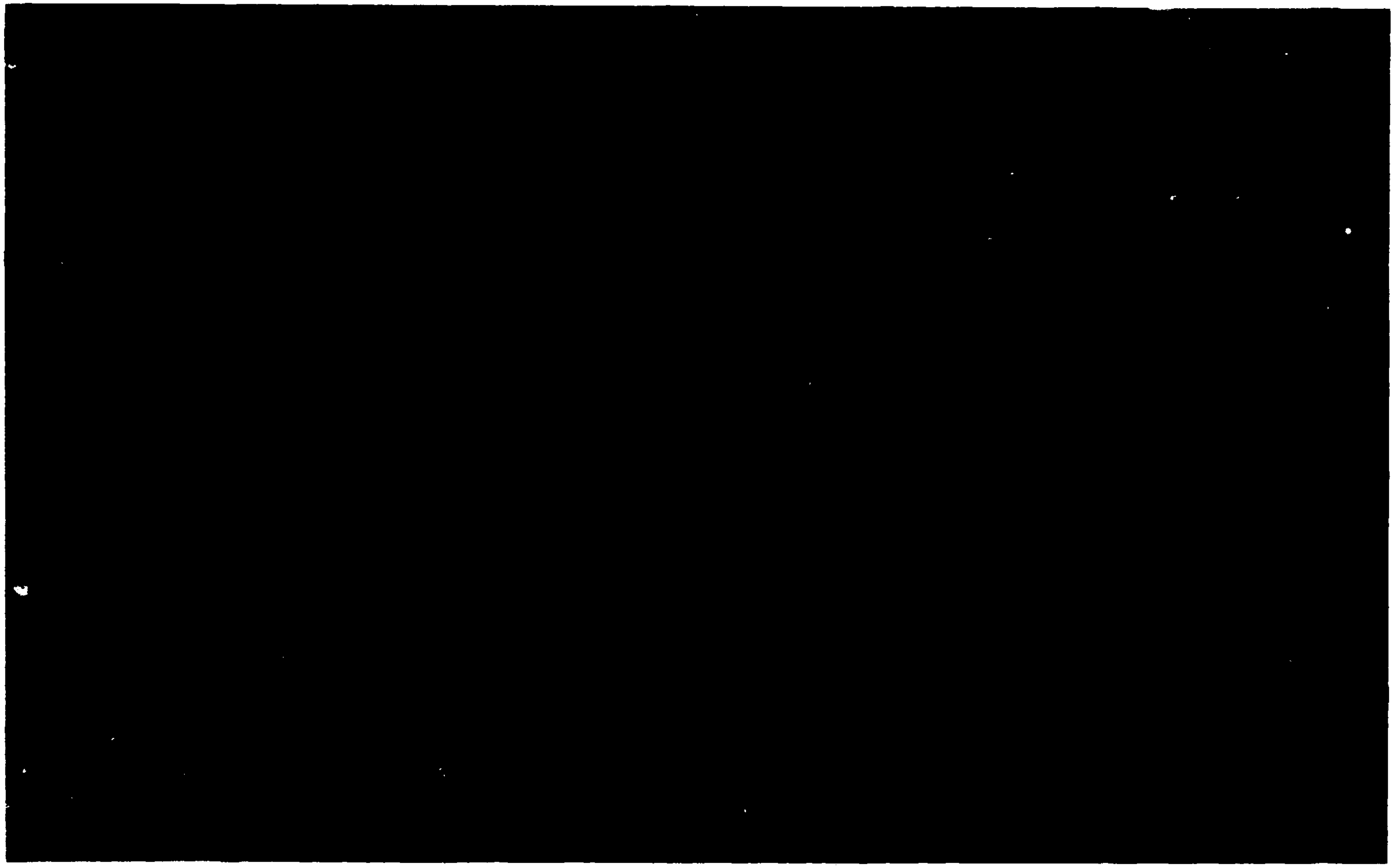


Photo 166. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW with Base Test 2 installed; swl = +6.7 ft

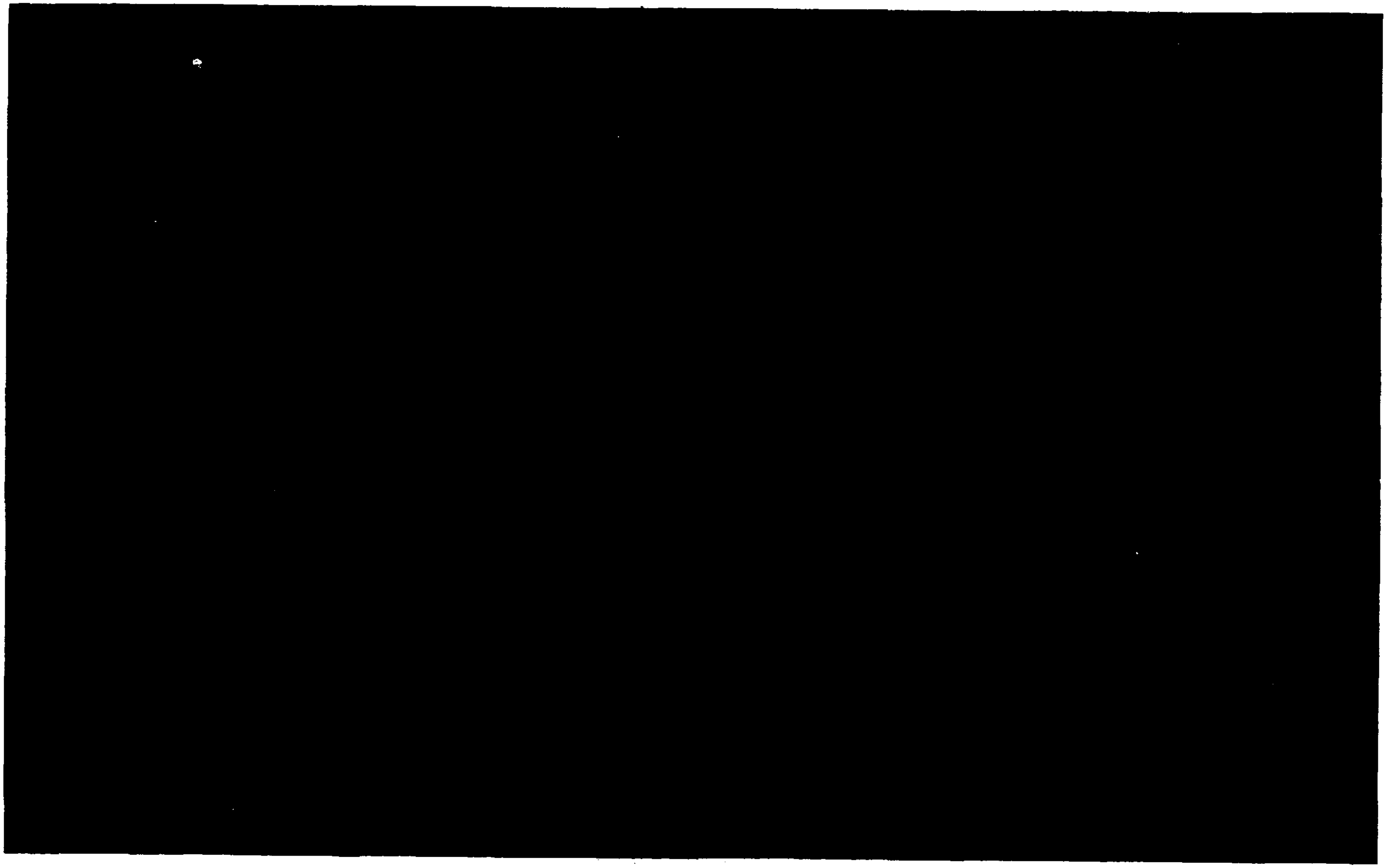


Photo 167. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW with Base Test 2 installed; swl = +6.7 ft

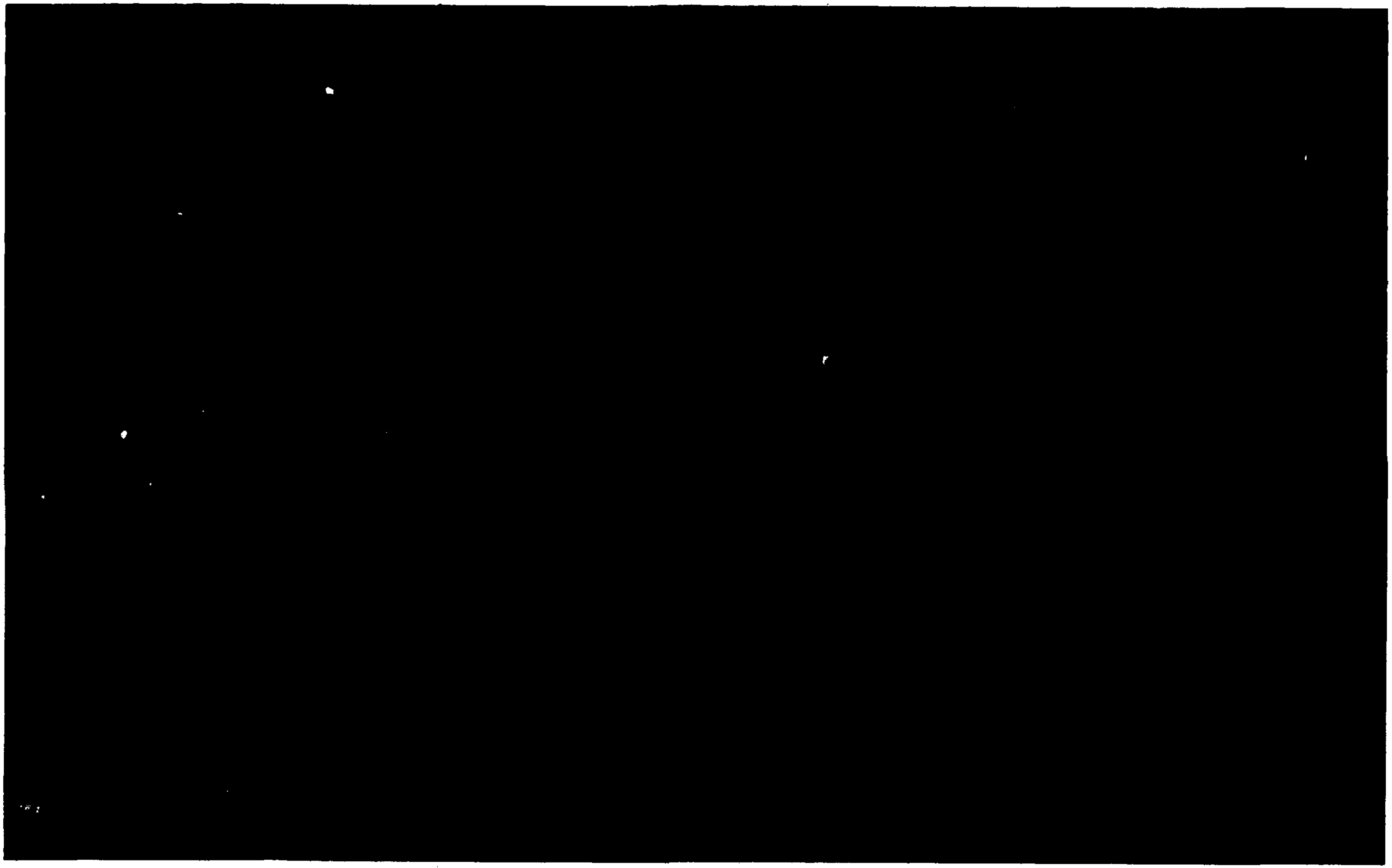


Photo 168. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW with Base Test 2 installed; swl = +6.7 ft

Photo 169. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW with Base Test 2 installed; swl = 0.0 ft

Photo 170. General movement of tracer material and deposits resulting from 11-sec, 12-waves from SSW with Base Test 2 installed; swl = 0.0 ft

Photo 171. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW with Base Test 2 installed; swl = 0.0 ft

Photo 172. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

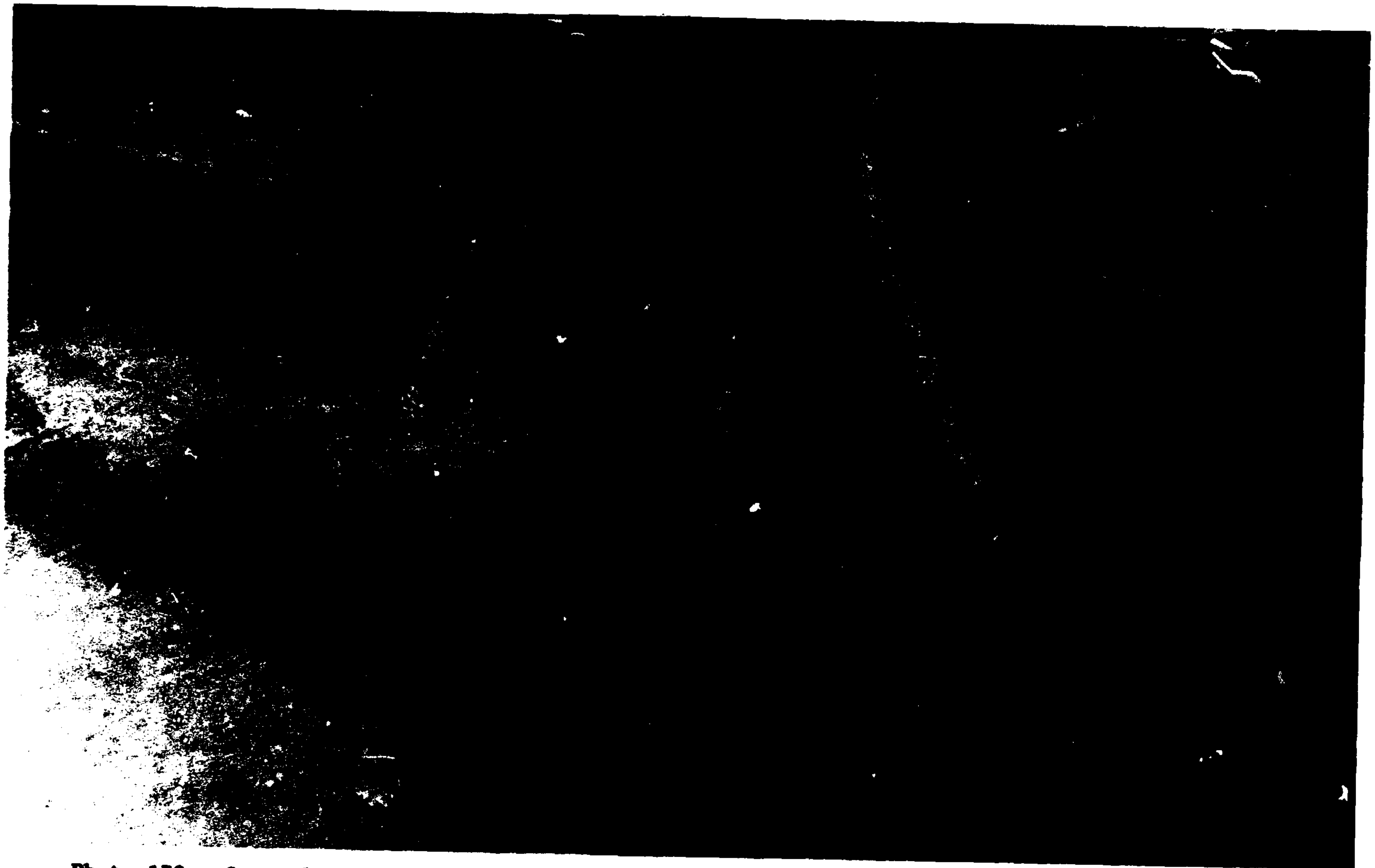
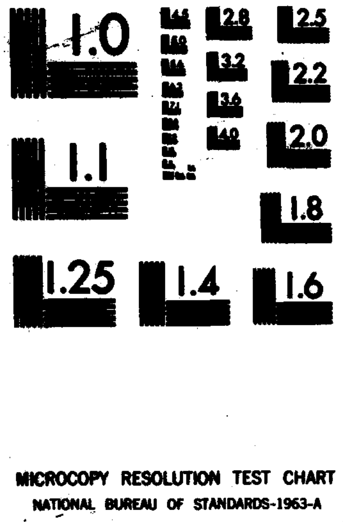


Photo 173. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

AD-A120 826 DESIGN FOR FLOOD CONTROL WAVE PROTECTION AND PREVENTION 4/7
OF SHOALING ROGUE..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
UNCLASSIFIED AUG 82 WES/TR/HL-82-18 F/G 13/2 NL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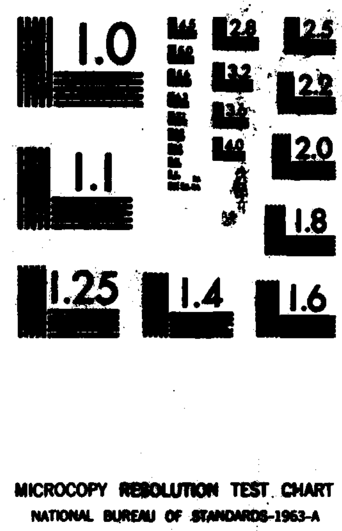
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A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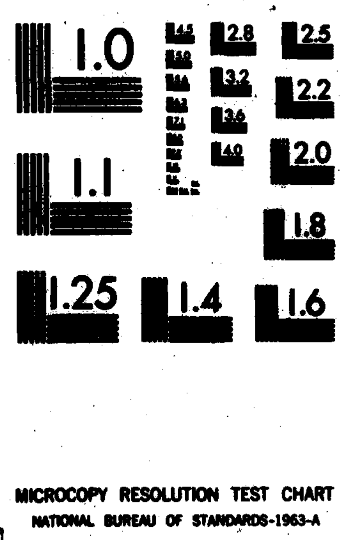
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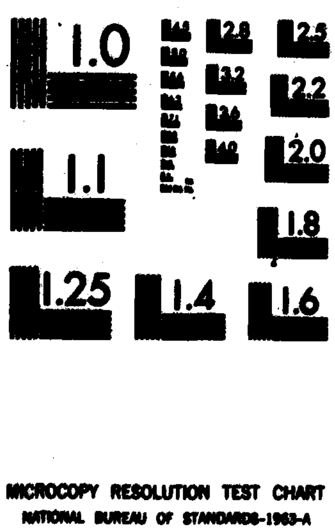
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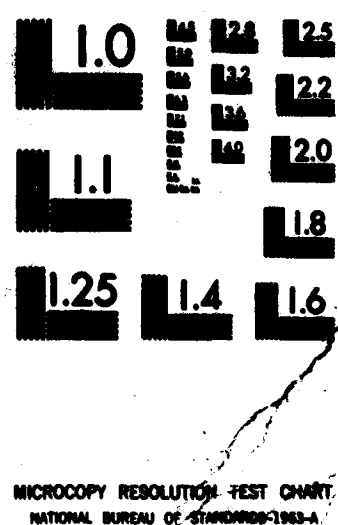
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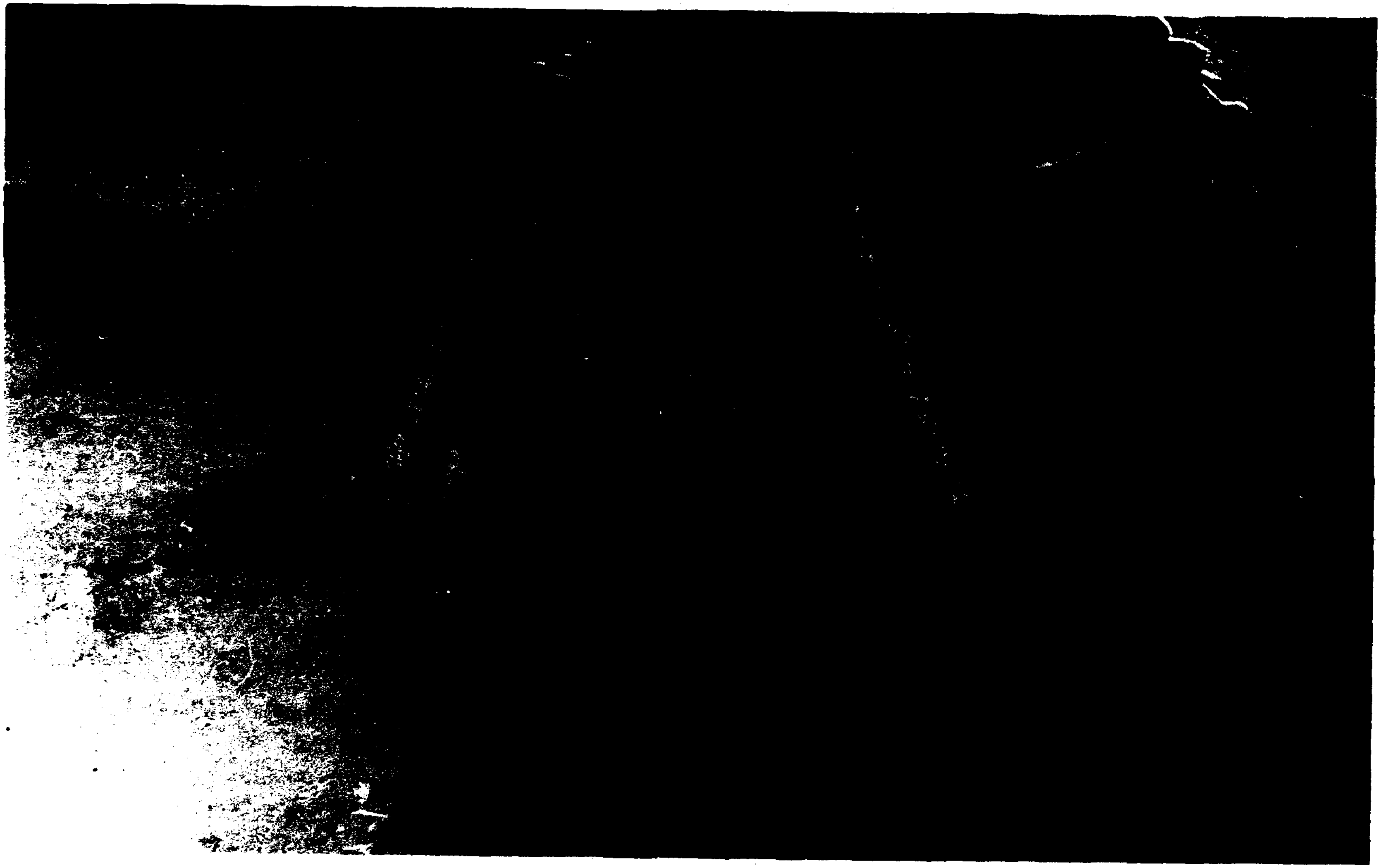

Photo 174. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for maximum ebb with Base Test 2 installed; swl = +1.5 ft

Photo 175. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for maximum flood with Base Test 2 installed; swl = +4.3 ft

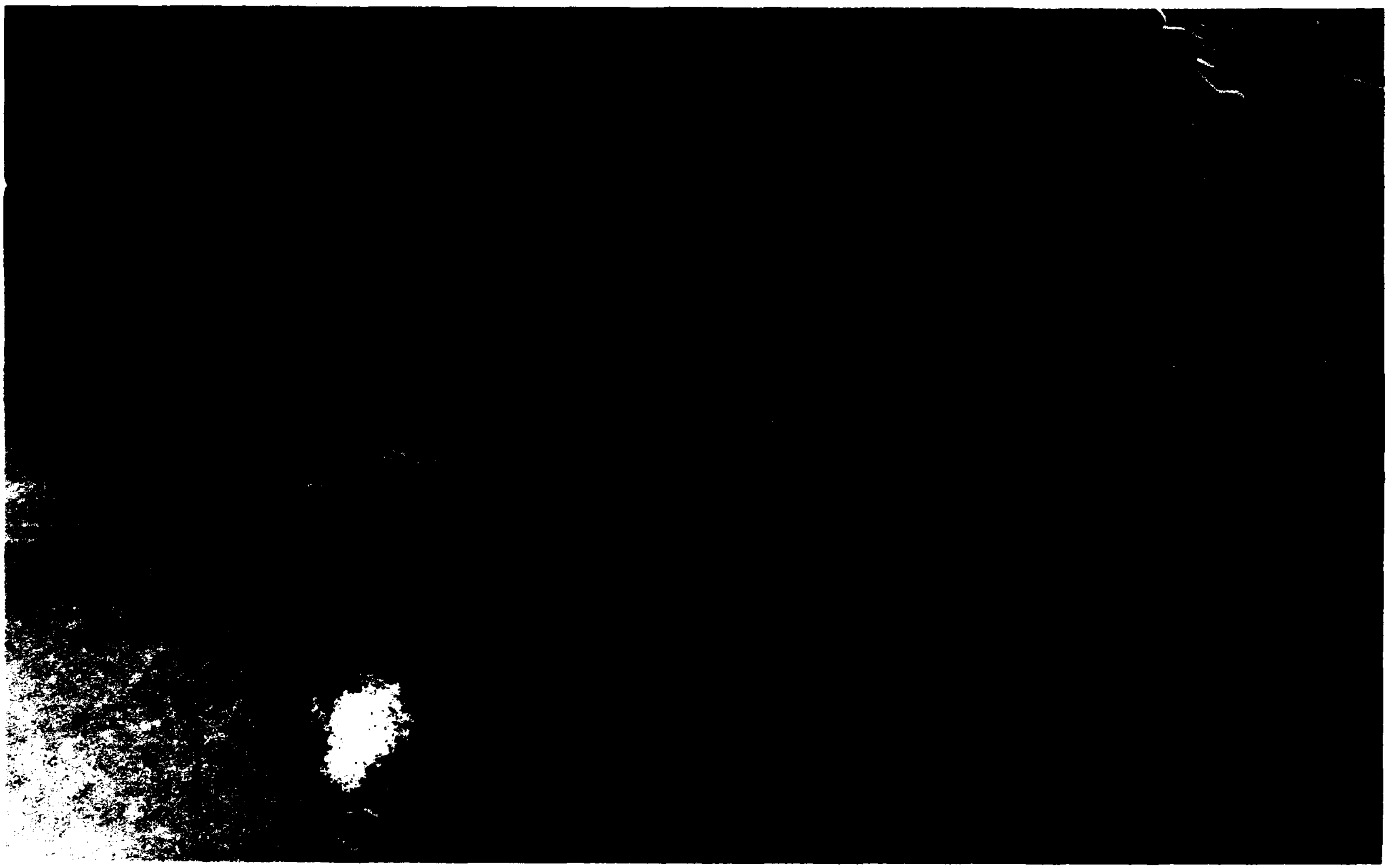

Photo 176. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum flood with Base Test 2 installed; swl = +4.3 ft

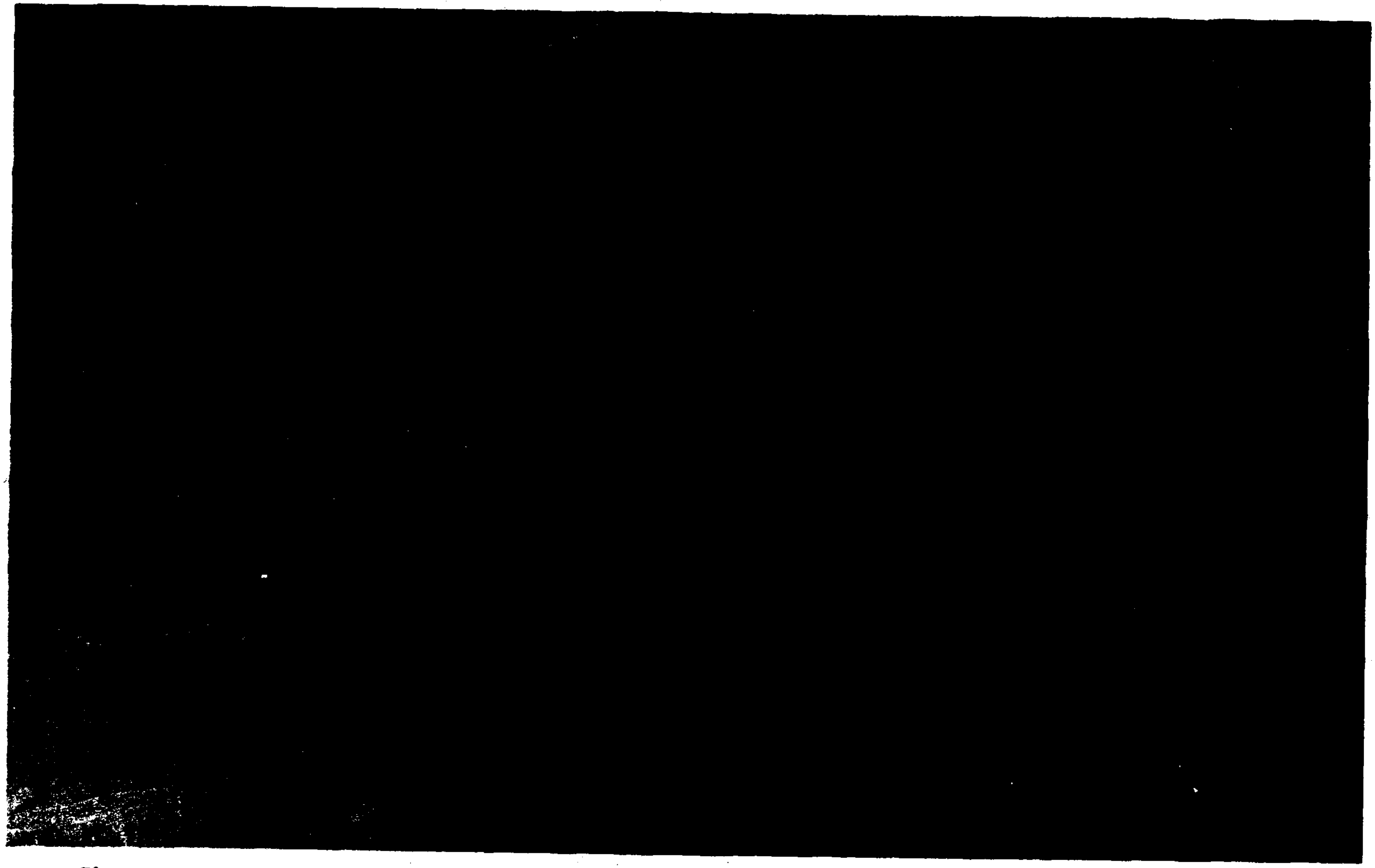

Photo 177. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for maximum flood with Base Test 2 installed; swl = +4.3 ft

Photo 178. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW with Base Test 2 installed; swl = +6.7 ft

Photo 179. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW with Base Test 2 installed; swl = +6.7 ft

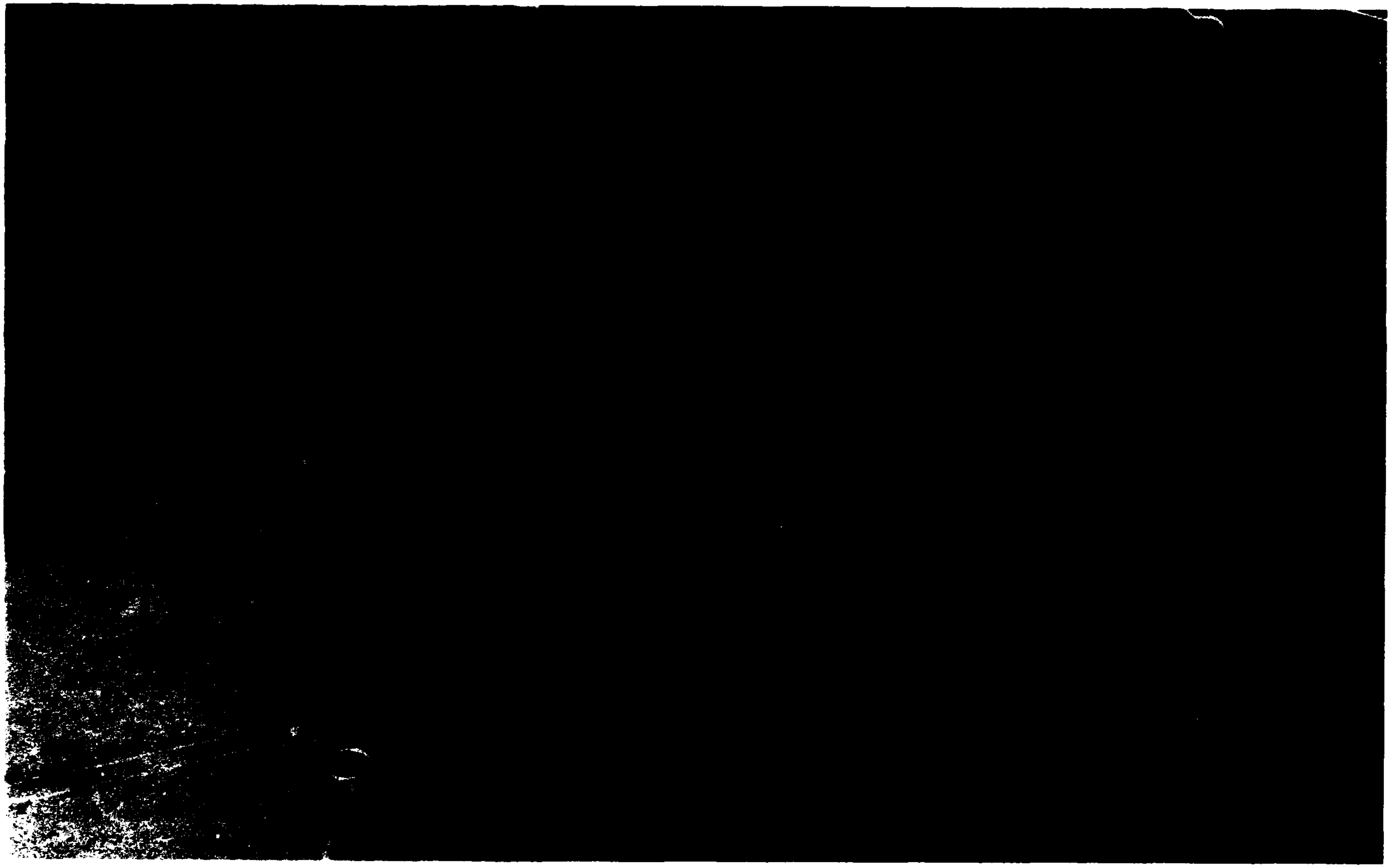

Photo 180. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW with Base Test 2 installed; swl = +6.7 ft

Photo 181. Shoal formed for Base Test 2; 13-sec, 7-ft waves from west

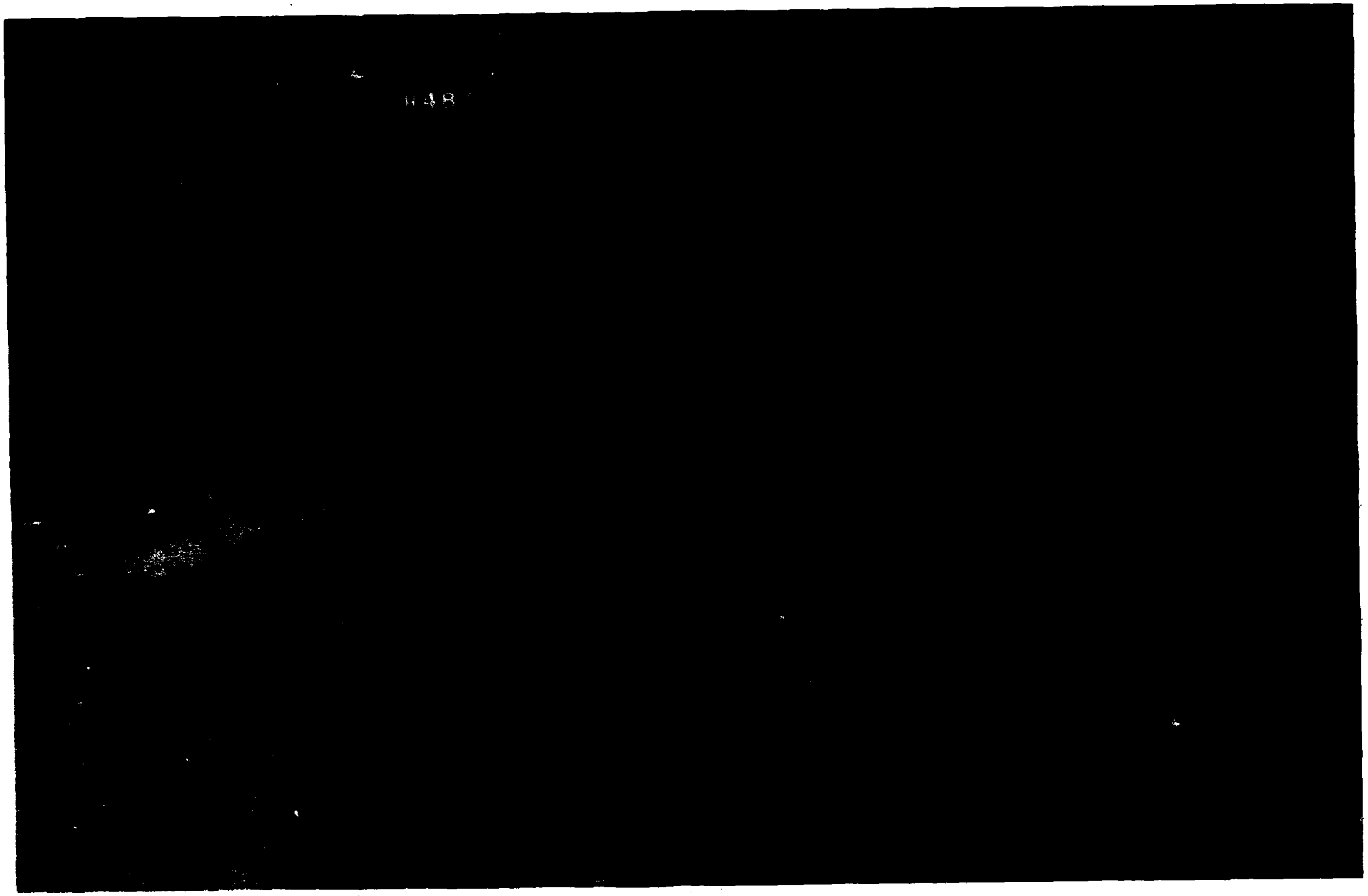

Photo 182. Shoal formed for Base Test 2; 13-sec, 27-ft waves from SW

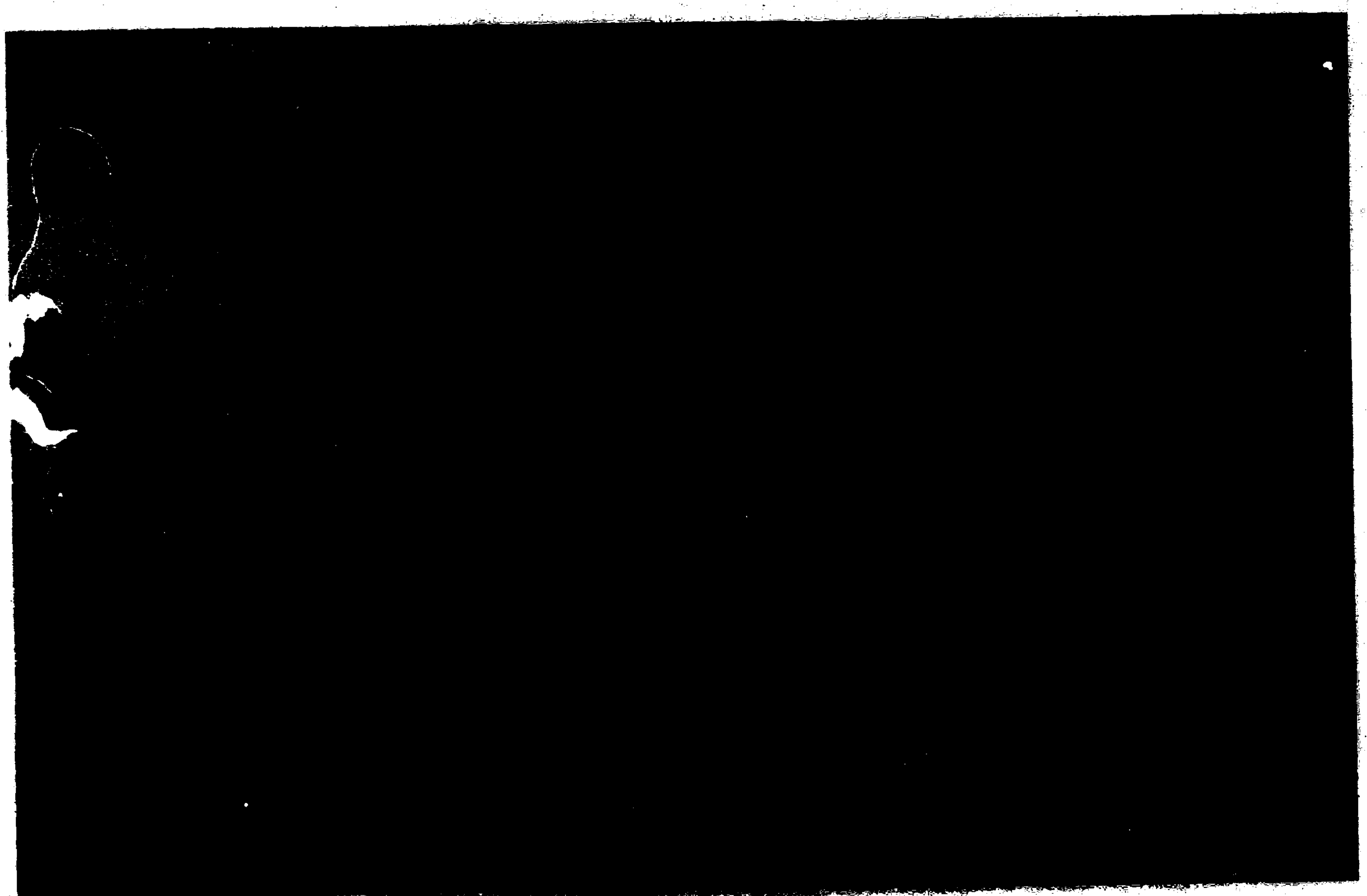

Photo 183. Closer view of shoal formed for Base Test 2; 13-sec, 27-ft waves from SW

Photo 184. Vertical view of shoal formed for Base Test 2; 13-sec, 27-ft waves from SW

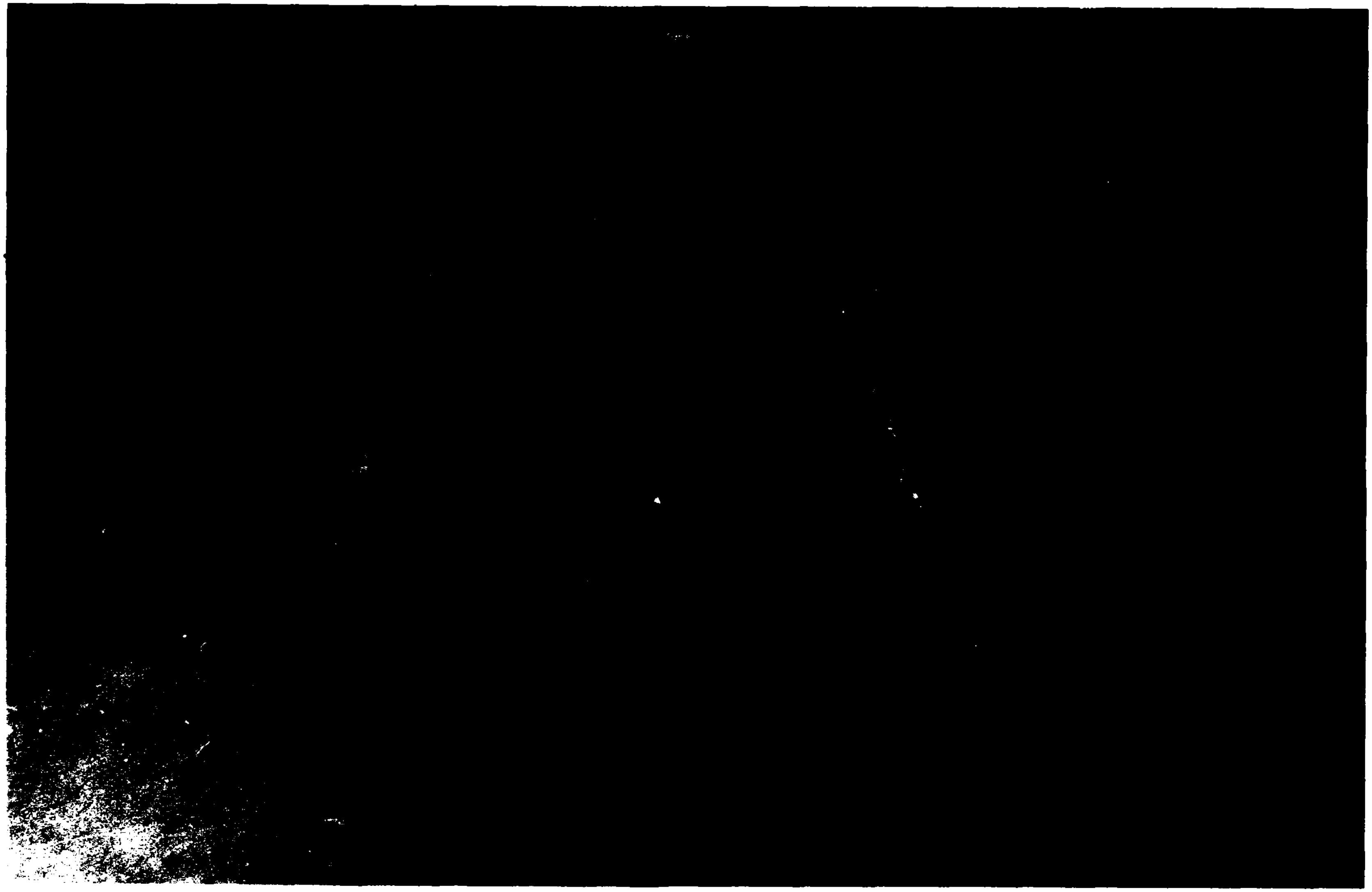

Photo 185. Shoaling patterns resulting from 150,000-cfs river discharge; Base Test 2

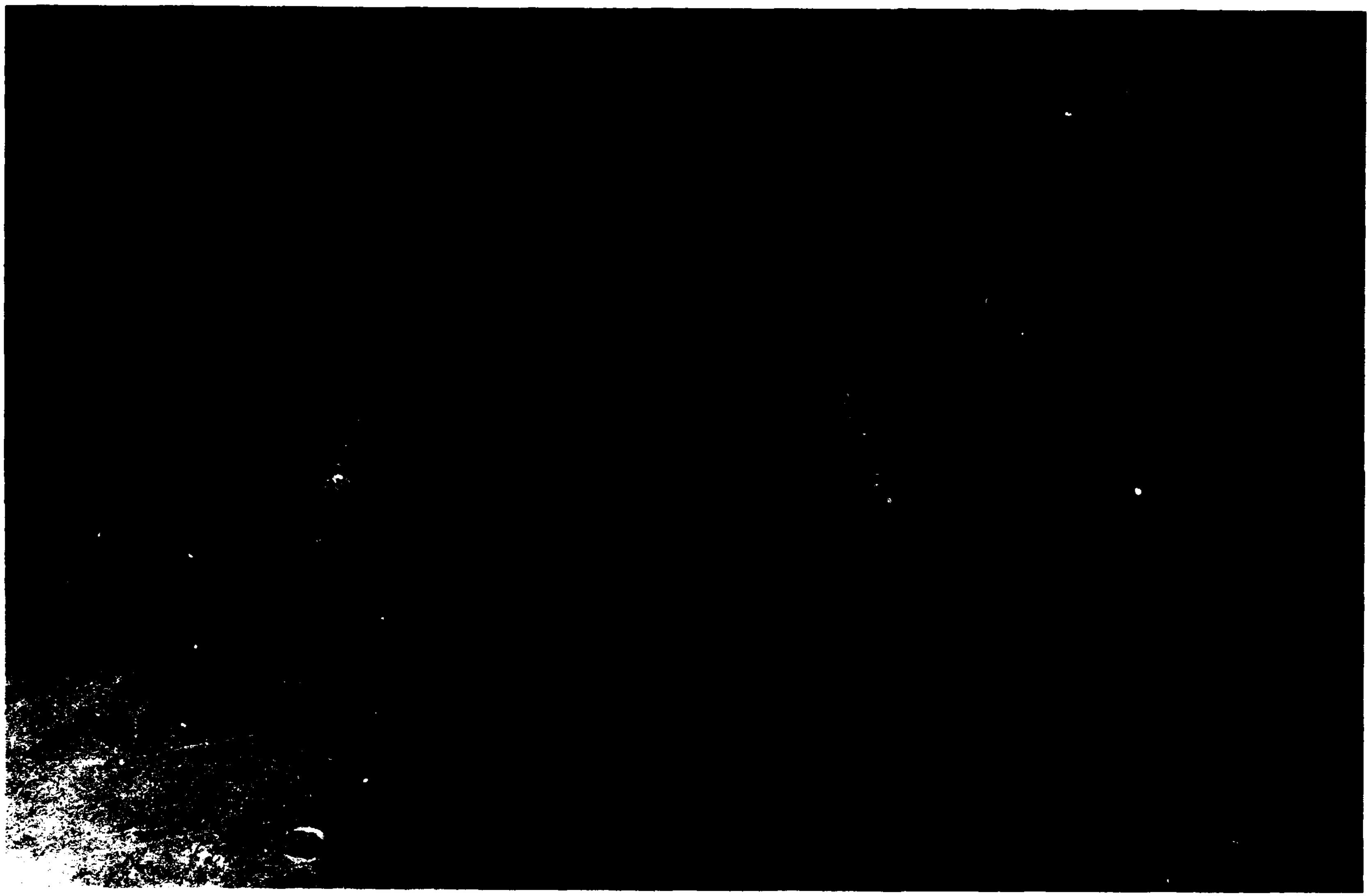

Photo 186. Shoaling patterns resulting from 200,000-cfs river discharge; Base Test 2

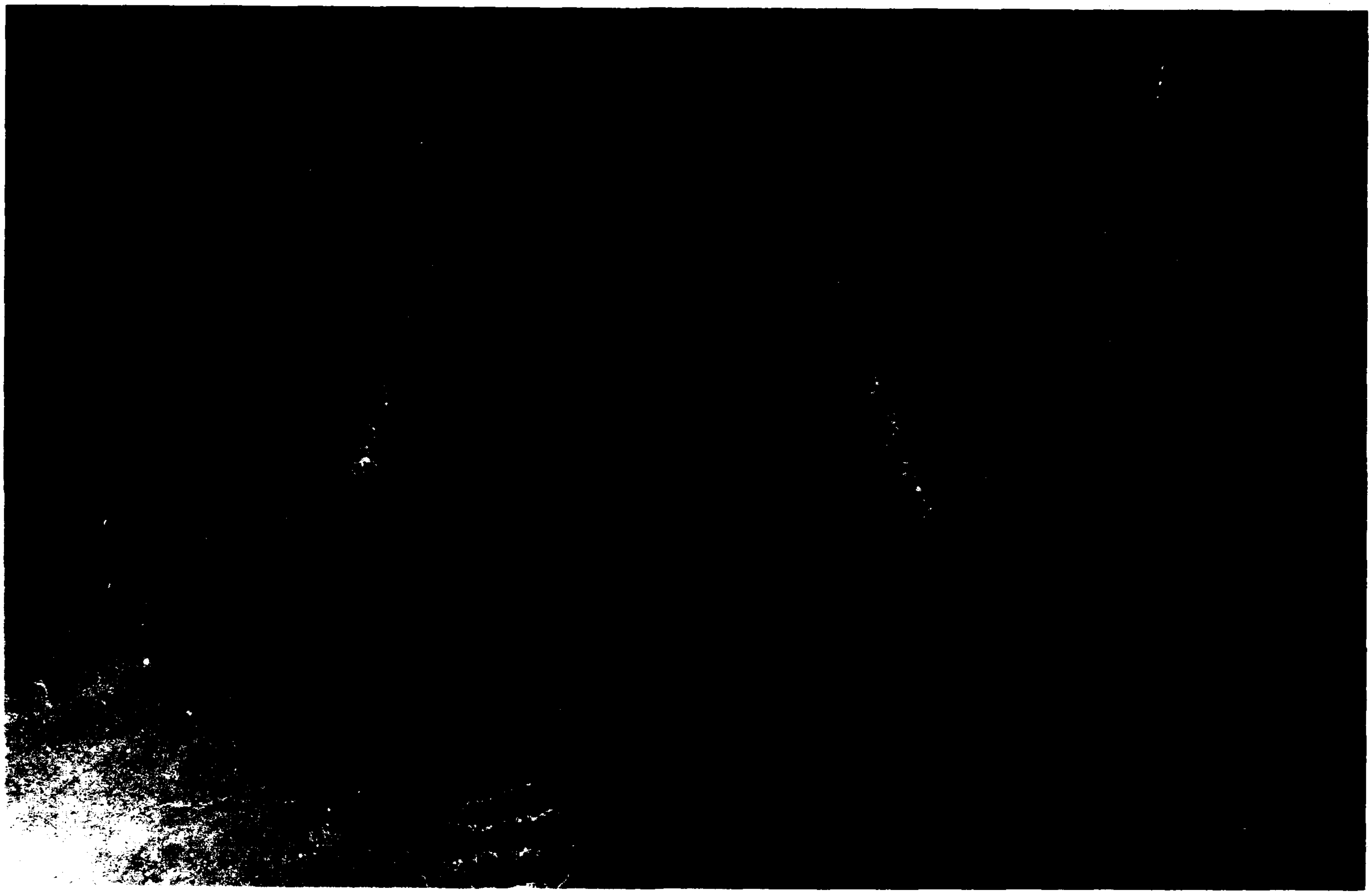

Photo 187. Shoaling patterns resulting from 300,000-cfs river discharge; Base Test 2

Photo 188. Shoaling patterns resulting from 350,000-cfs river discharge; Base Test 2

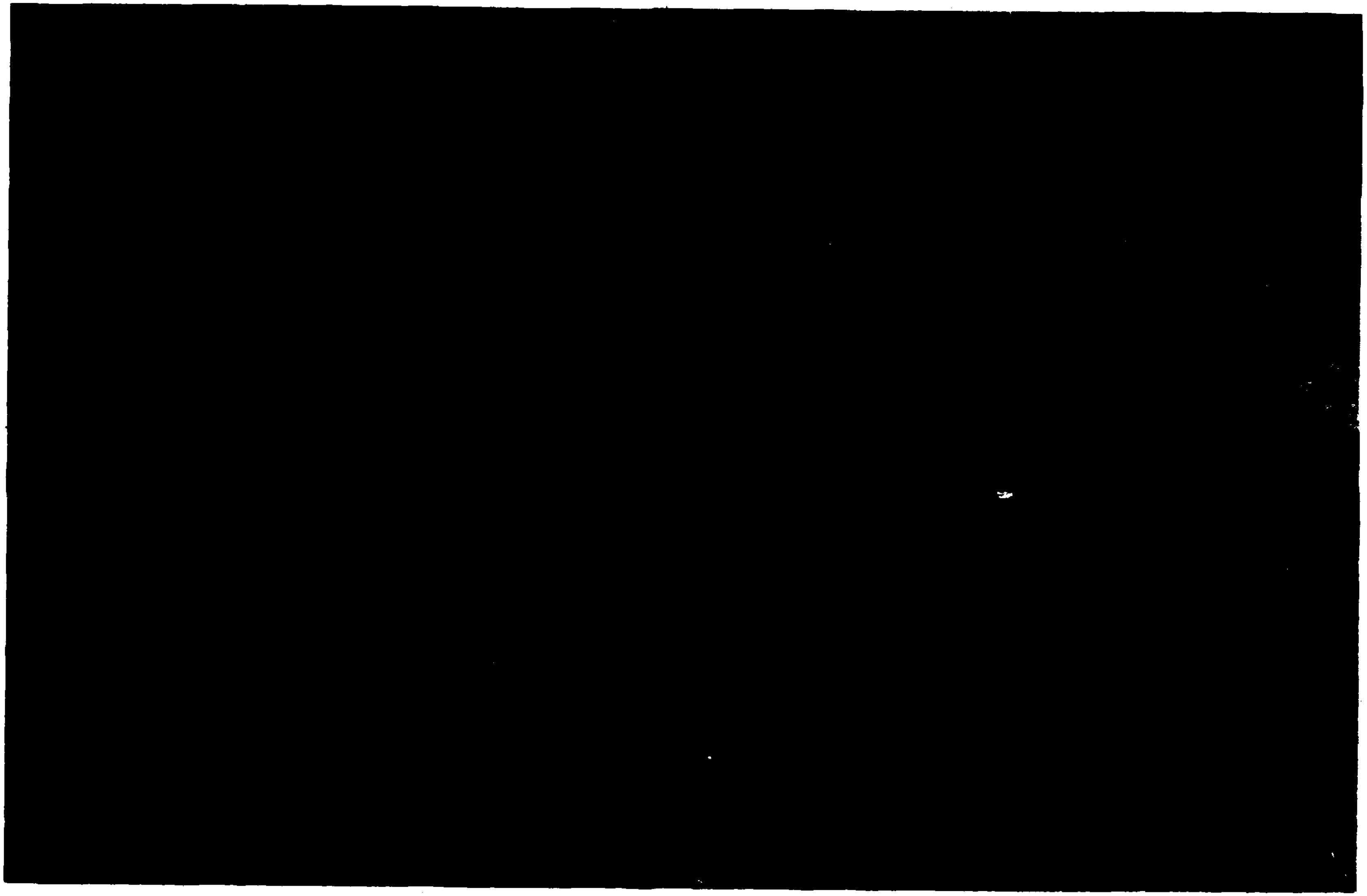

Photo 189. Typical river bed-load movement for Base Test 2

Photo 190. Shoal formed for Plan 1; 13-sec, 27-ft waves from SW

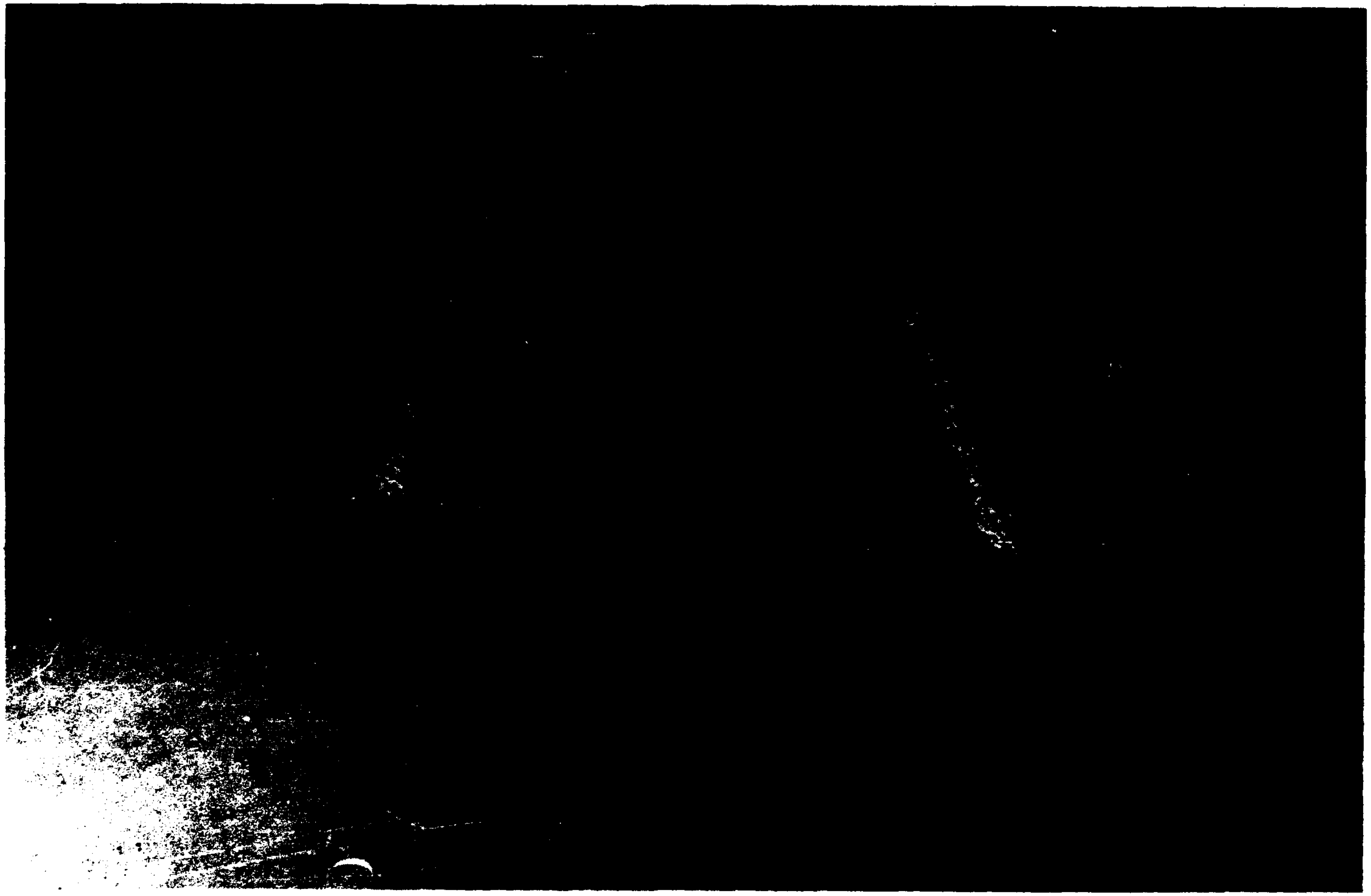

Photo 191. Shoal formed for Plan 2; 13-sec, 27-ft waves from SW

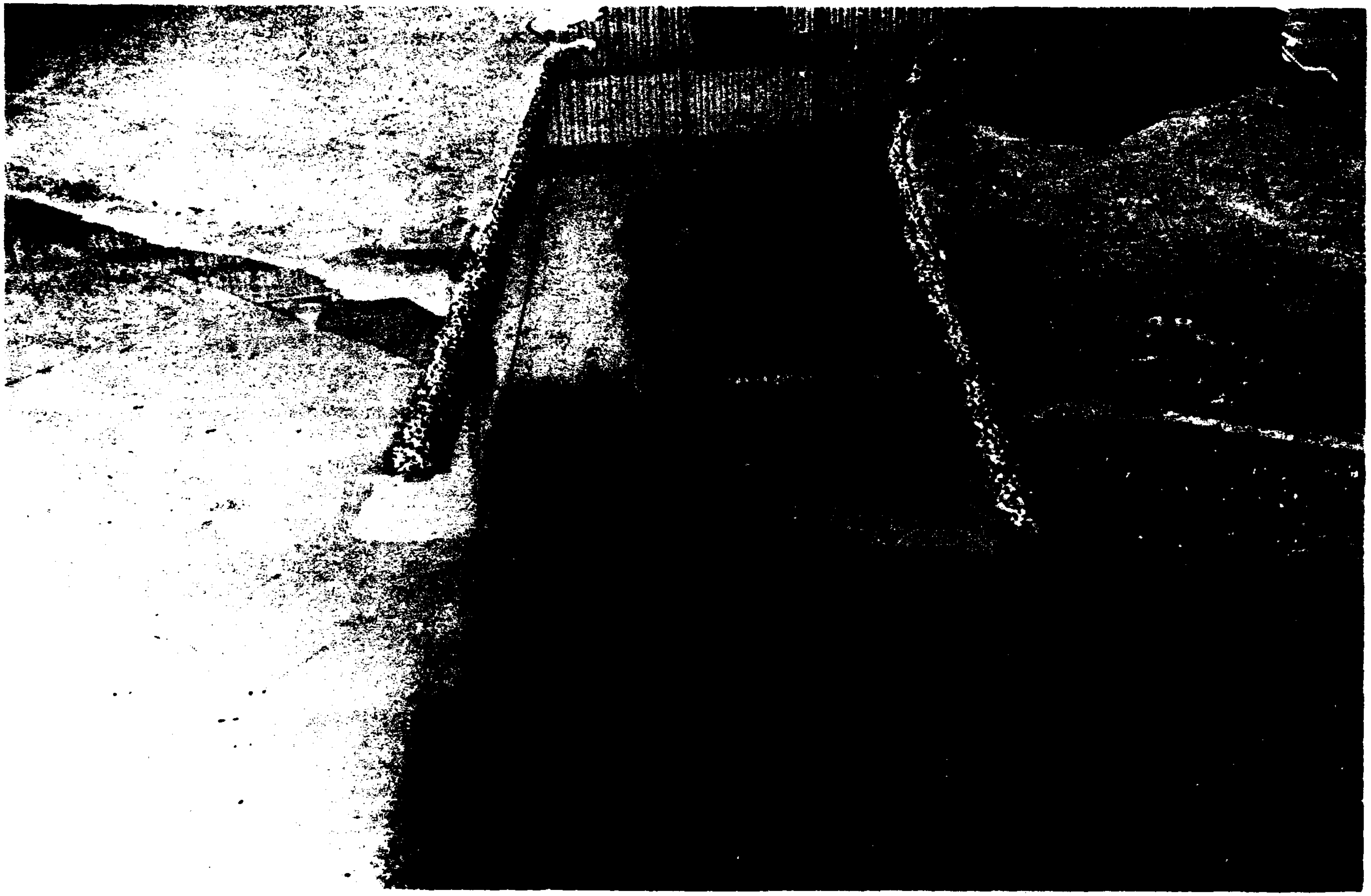

Photo 192. Shoaling patterns resulting from 150,000-cfs river discharge; Plan 2

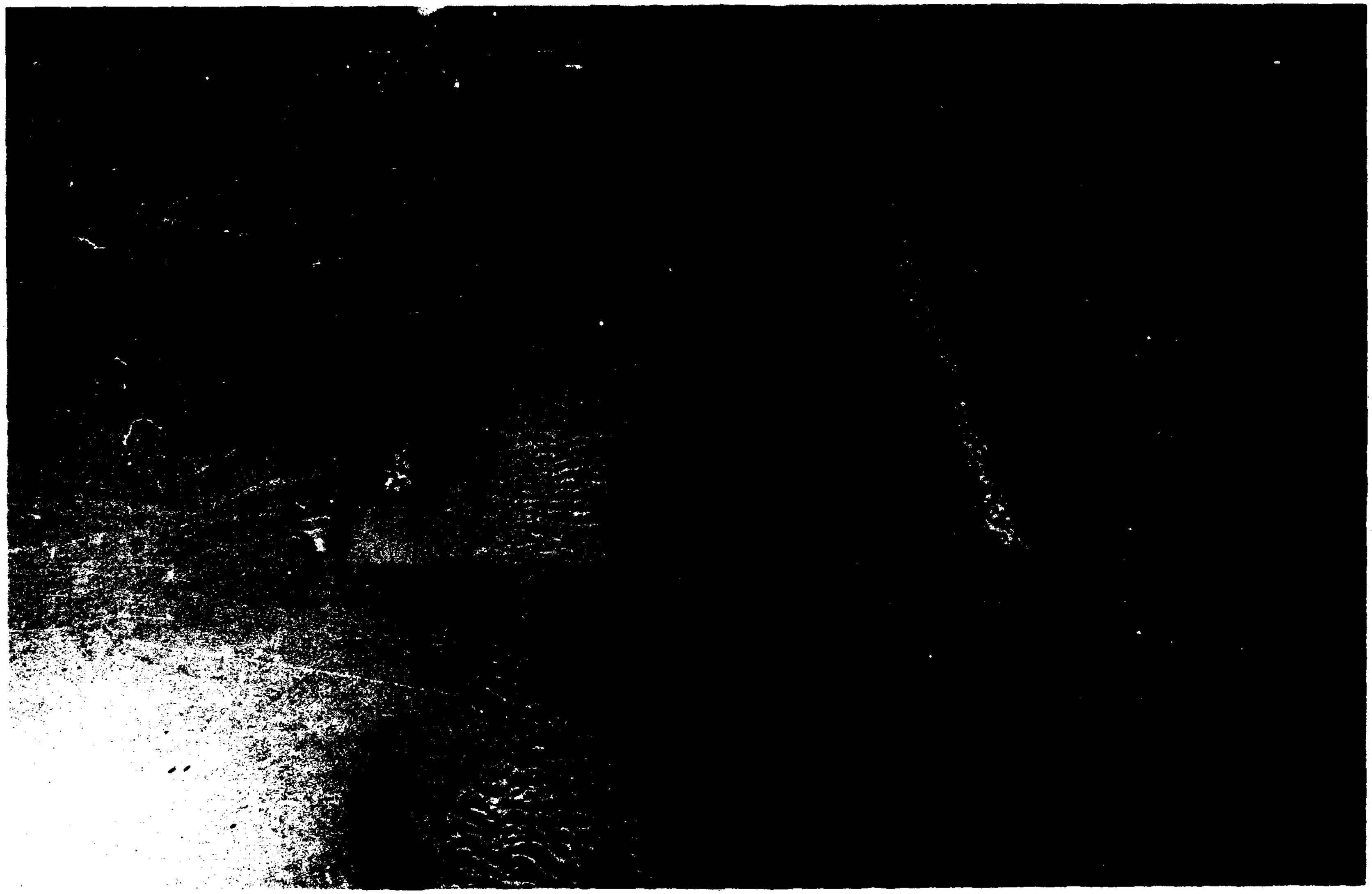

Photo 193. Shoaling patterns resulting from 200,000-cfs river discharge; Plan 2

Photo 194. Shoaling patterns resulting from 250,000-cfs river discharge; Plan 2

Photo 195. Shoaling patterns resulting from 300,000-cfs river discharge; Plan 2

Photo 196. Shoaling patterns resulting from 350,000-cfs river discharge; Plan 2

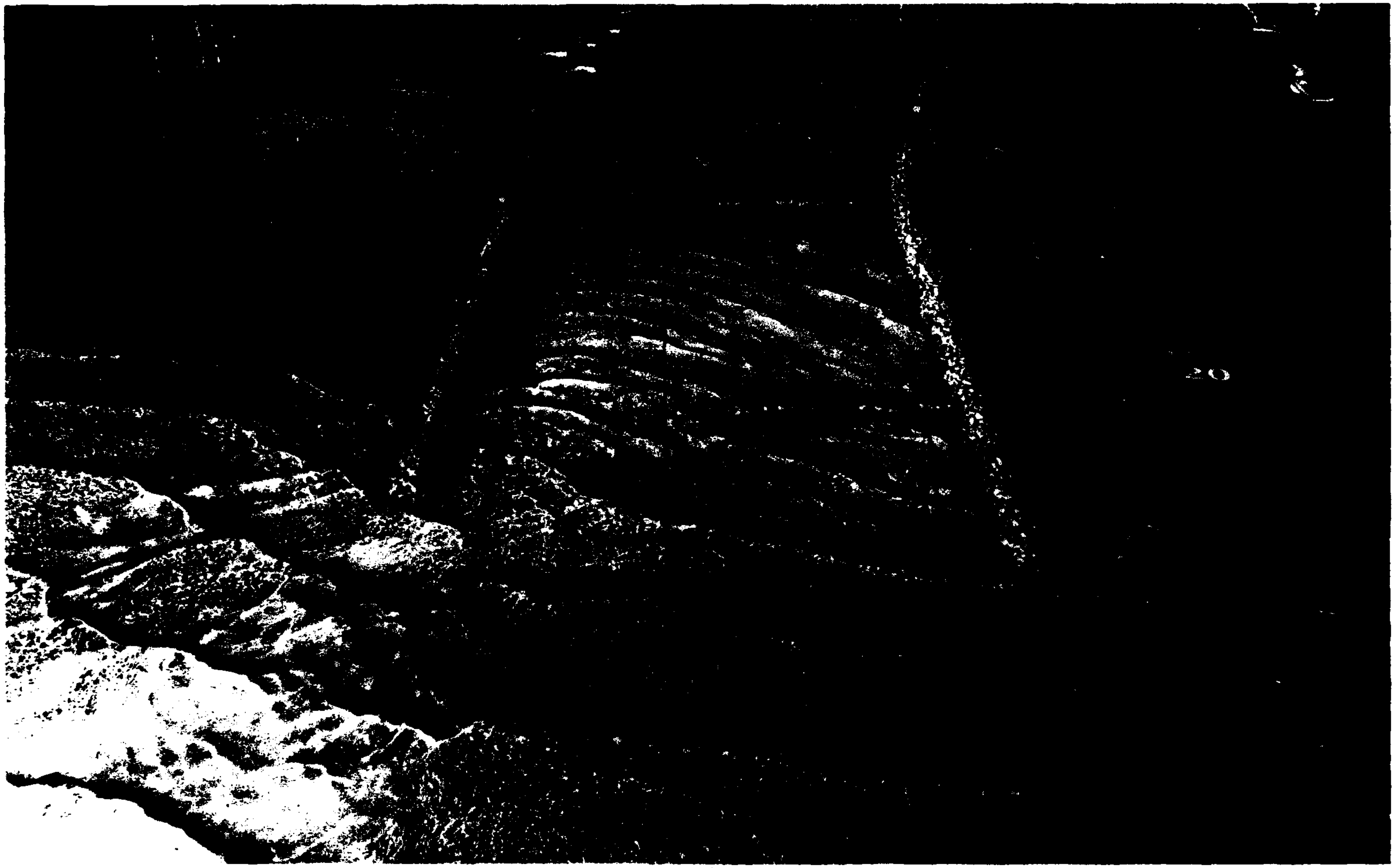

Photo 197. Typical wave patterns obtained for Plan 2; 13-sec, 27-ft waves from SW for maximum flood; swl = +4.3 ft

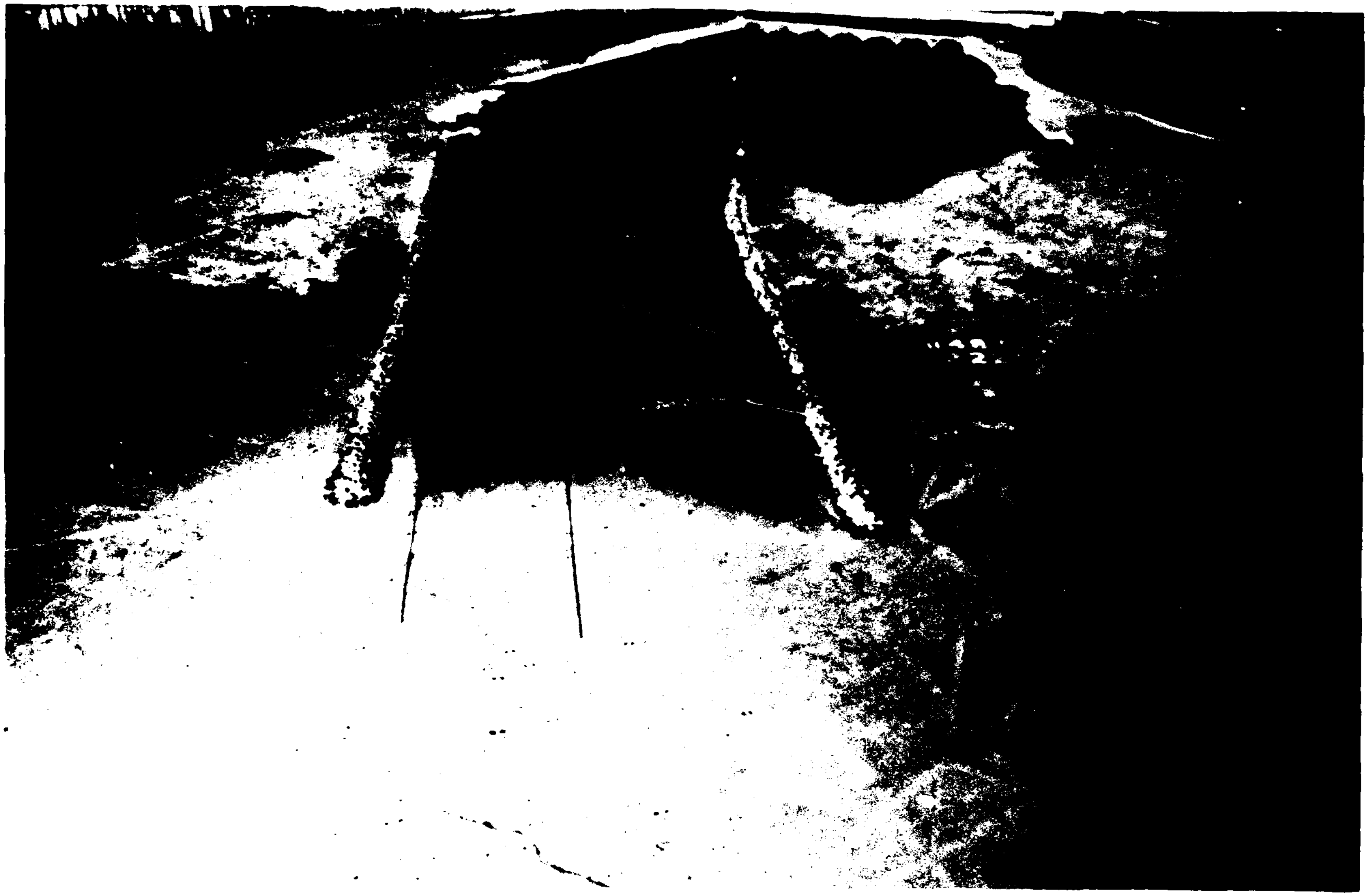

Photo 198. Shoal formed for Plan 2A; 13-sec, 27-ft waves from SW

Photo 199. Shoal formed for Plan 2A after prolonged testing; 13-sec, 27-ft waves from SW

Photo 200. Shoaling patterns resulting from 150,000-cfs river discharge, Plan 2A

Photo 201. Shoaling patterns resulting from 200,000-cfs river discharge; Plan 2A

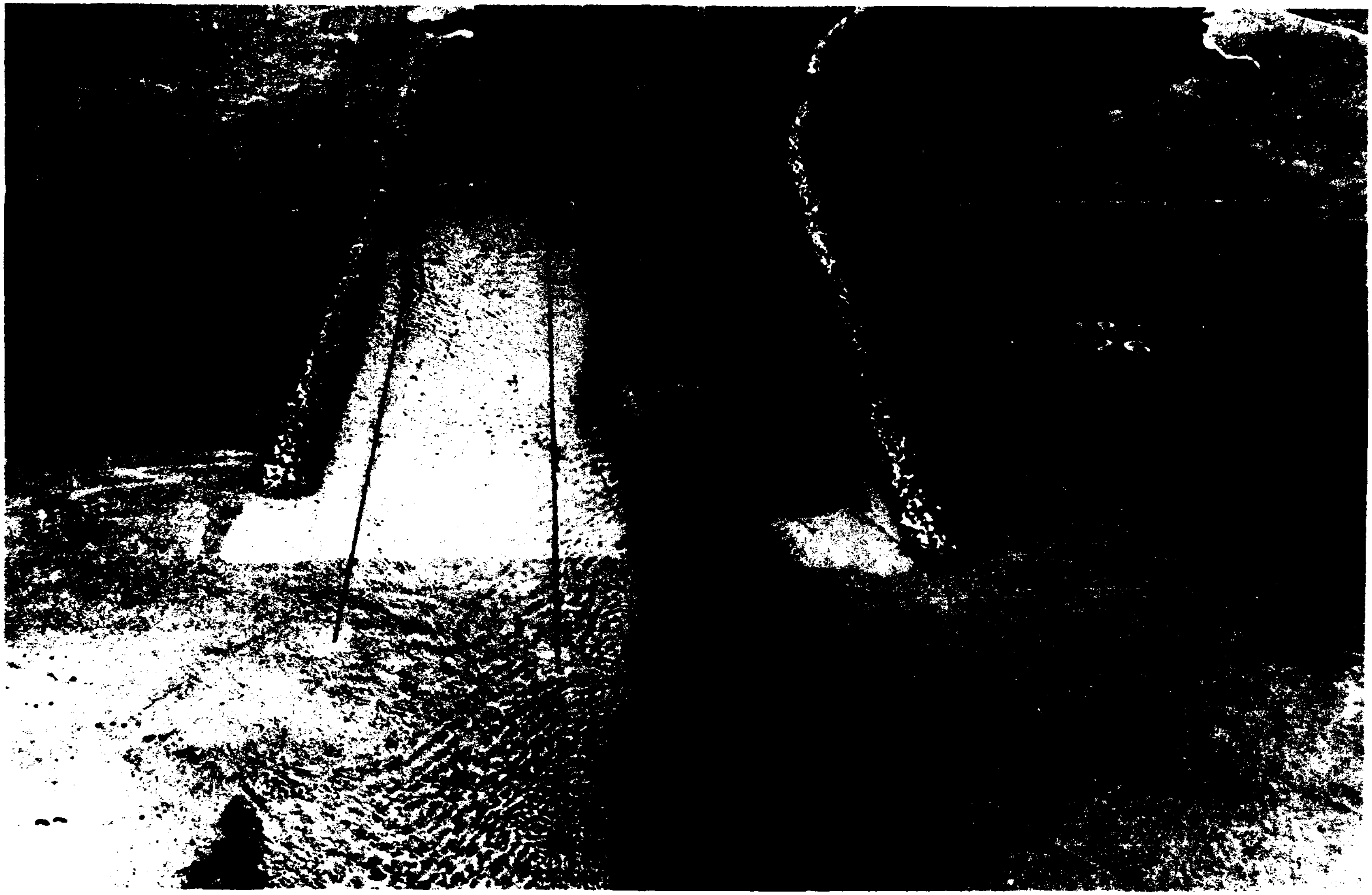

Photo 202. Shoaling patterns resulting from 250,000-cfs river discharge; Plan 2A

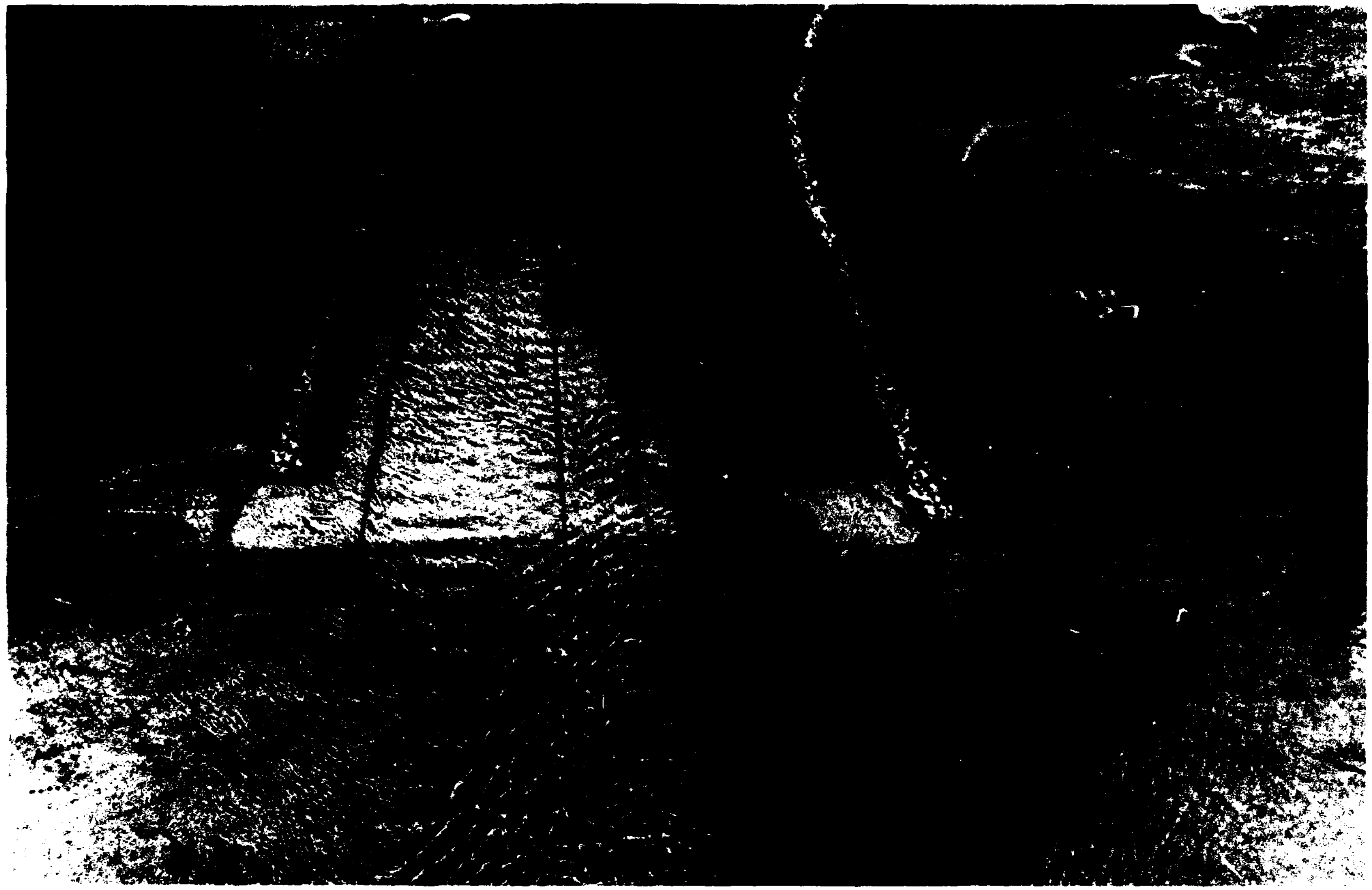

Photo 203. Shoaling patterns resulting from 300,000-cfs river discharge; Plan 2A

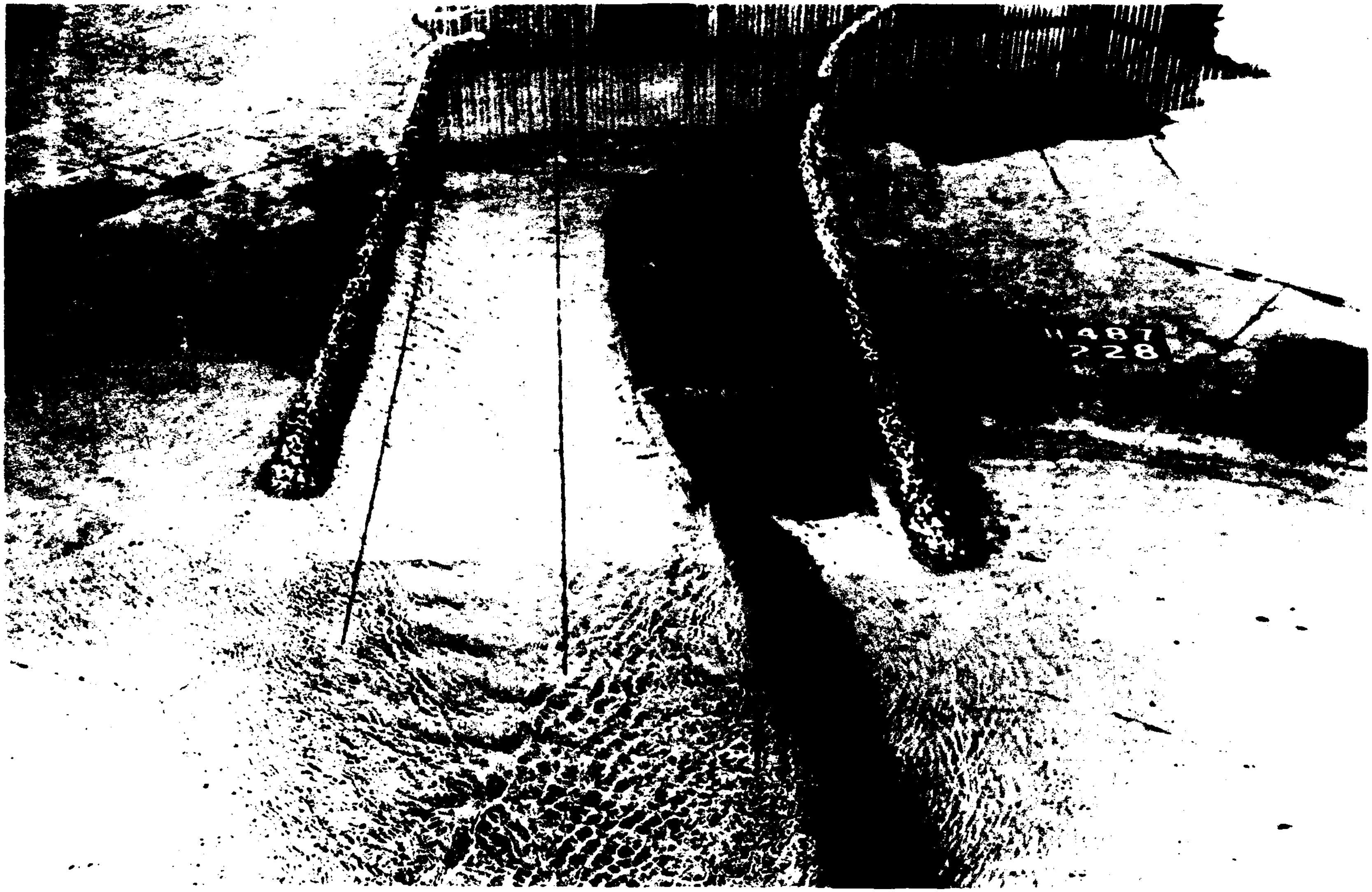

Photo 204. Shoaling patterns resulting from 350,000-cfs river discharge; Plan 2A

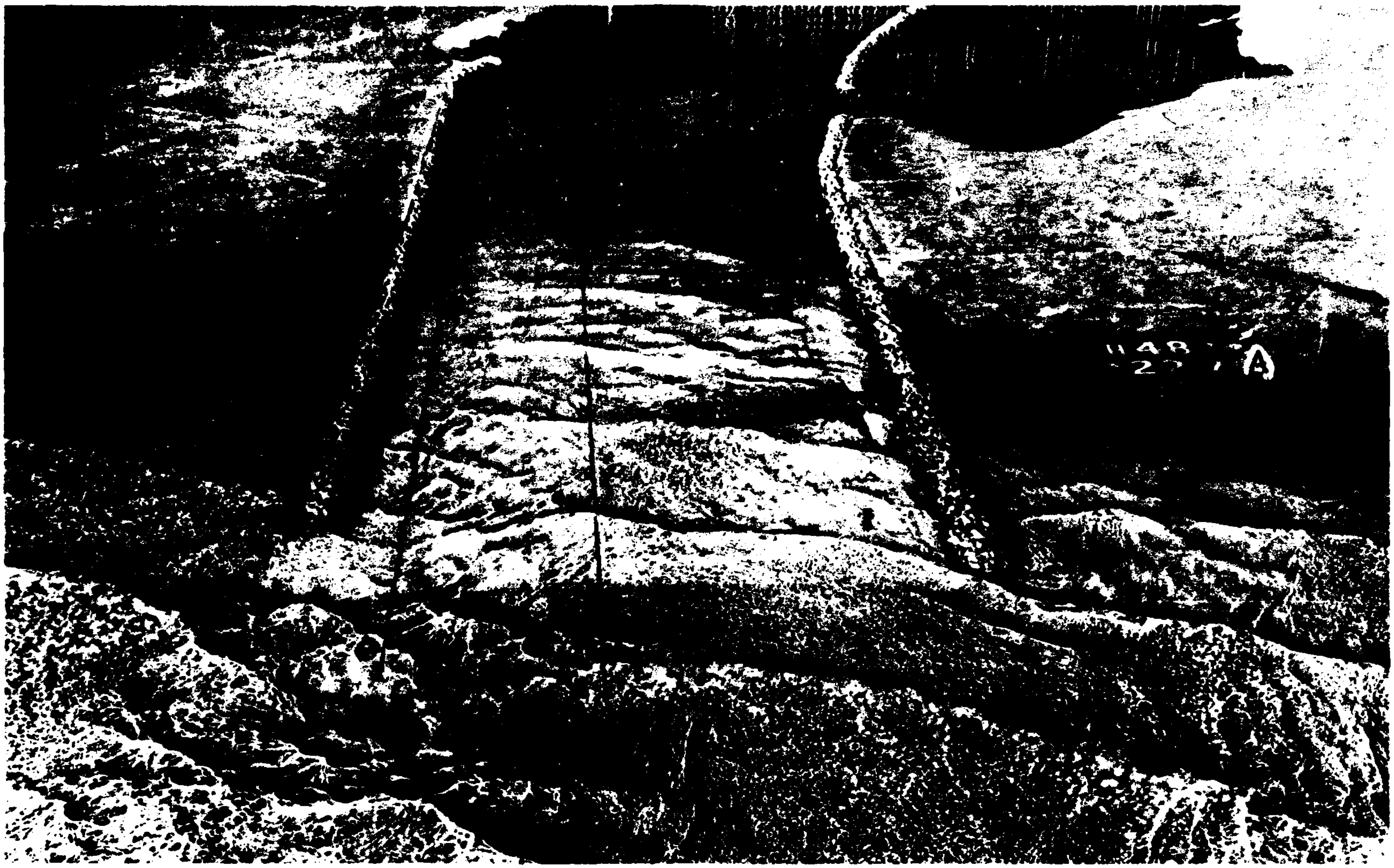

Photo 205. Typical patterns obtained for Plan 2A; 13-sec, 27-ft waves from SW for maximum flood; swl = +4.3 ft

Photo 206. Riverine sediment movement for Plan 2A; 150,000-cfs river discharge

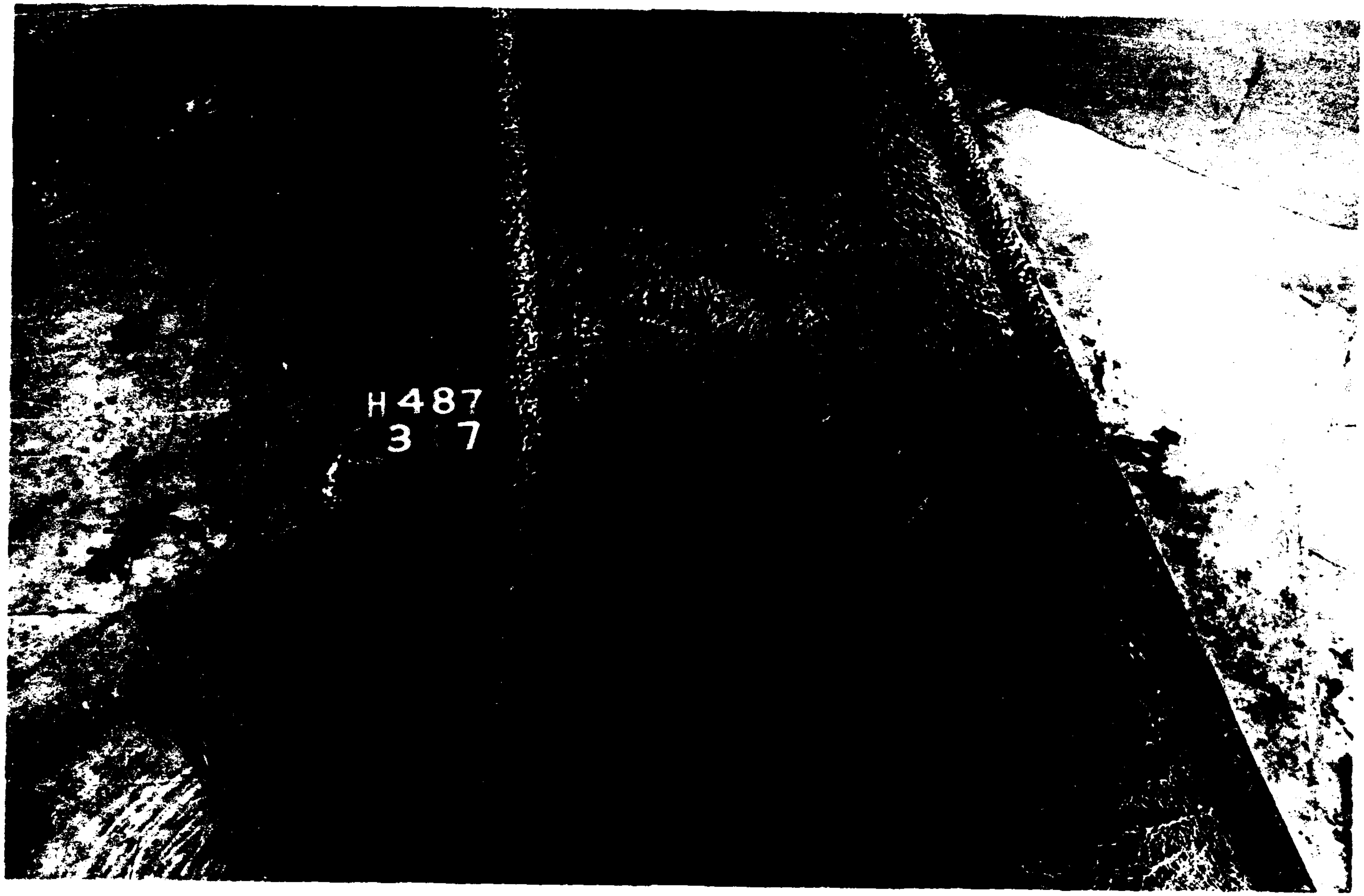

Photo 207. Riverine sediment movement for Plan 2A; 250,000-cfs river discharge

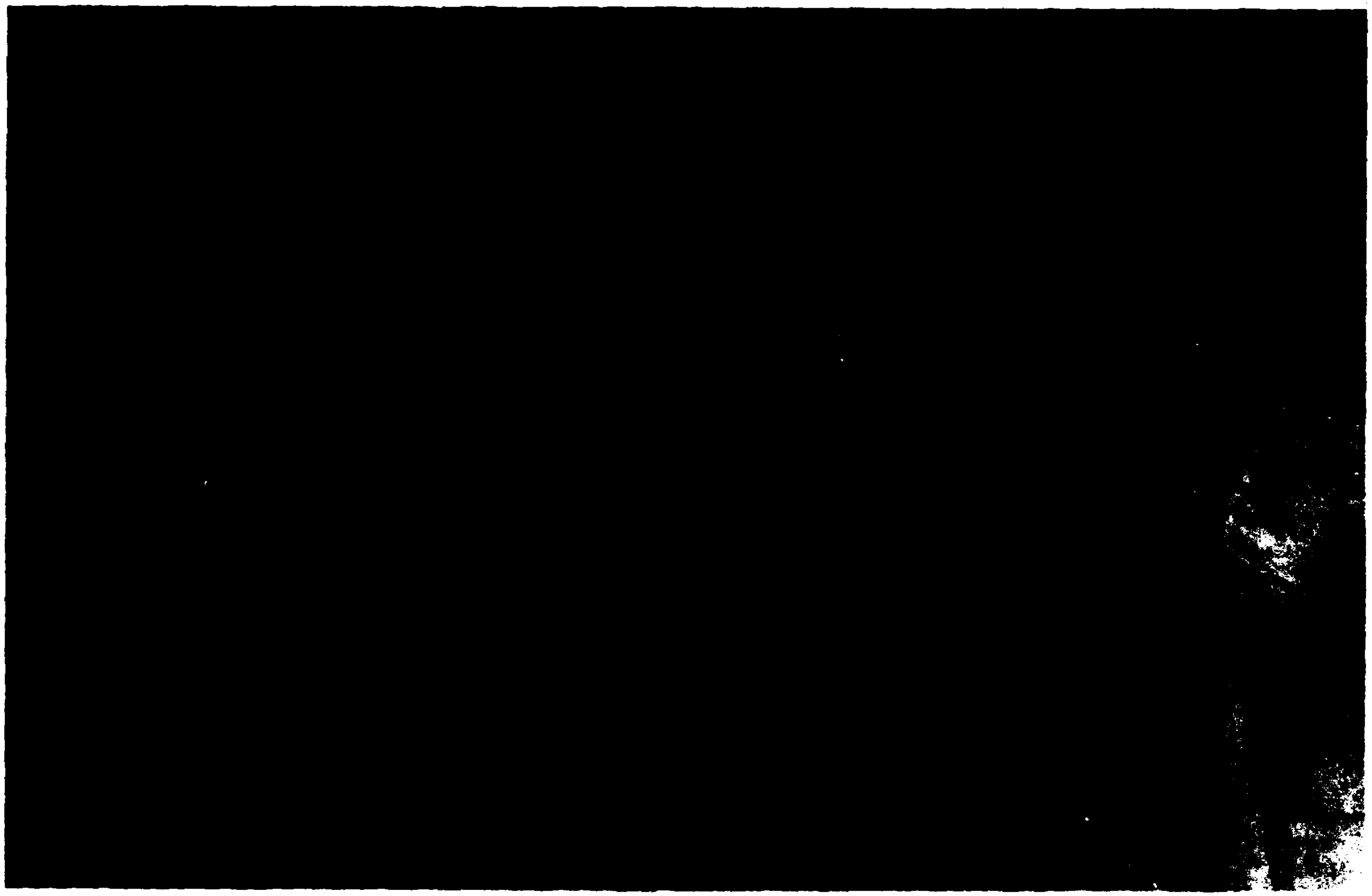

Photo 208. Riverine sediment movement for Plan 2A; 350,000-cfs river discharge

Photo 209. View of conveyance channel and weir section of Plan 3A with a 350,000-cfs river discharge

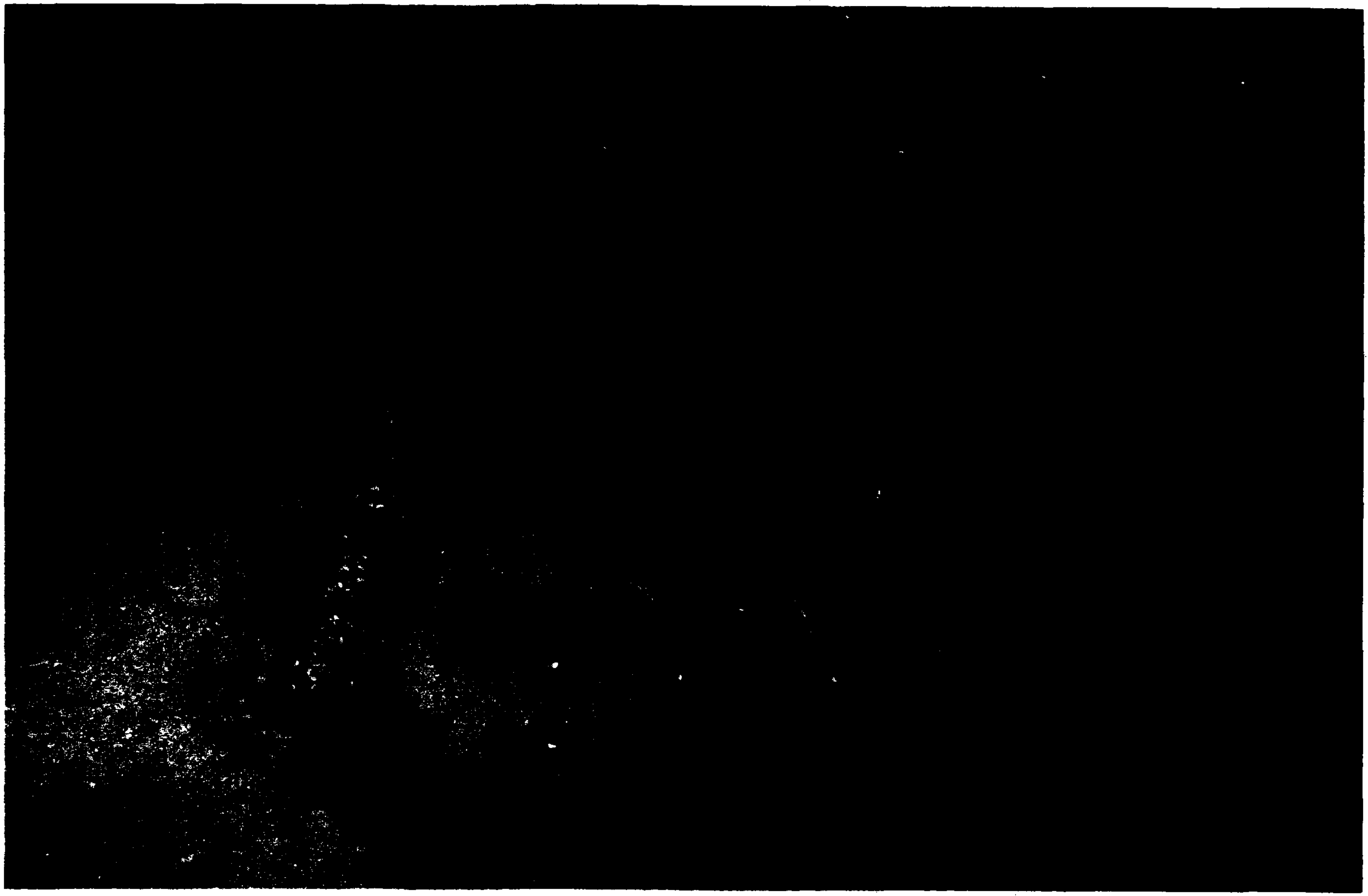

Photo 210. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4; swl = 0.0 ft

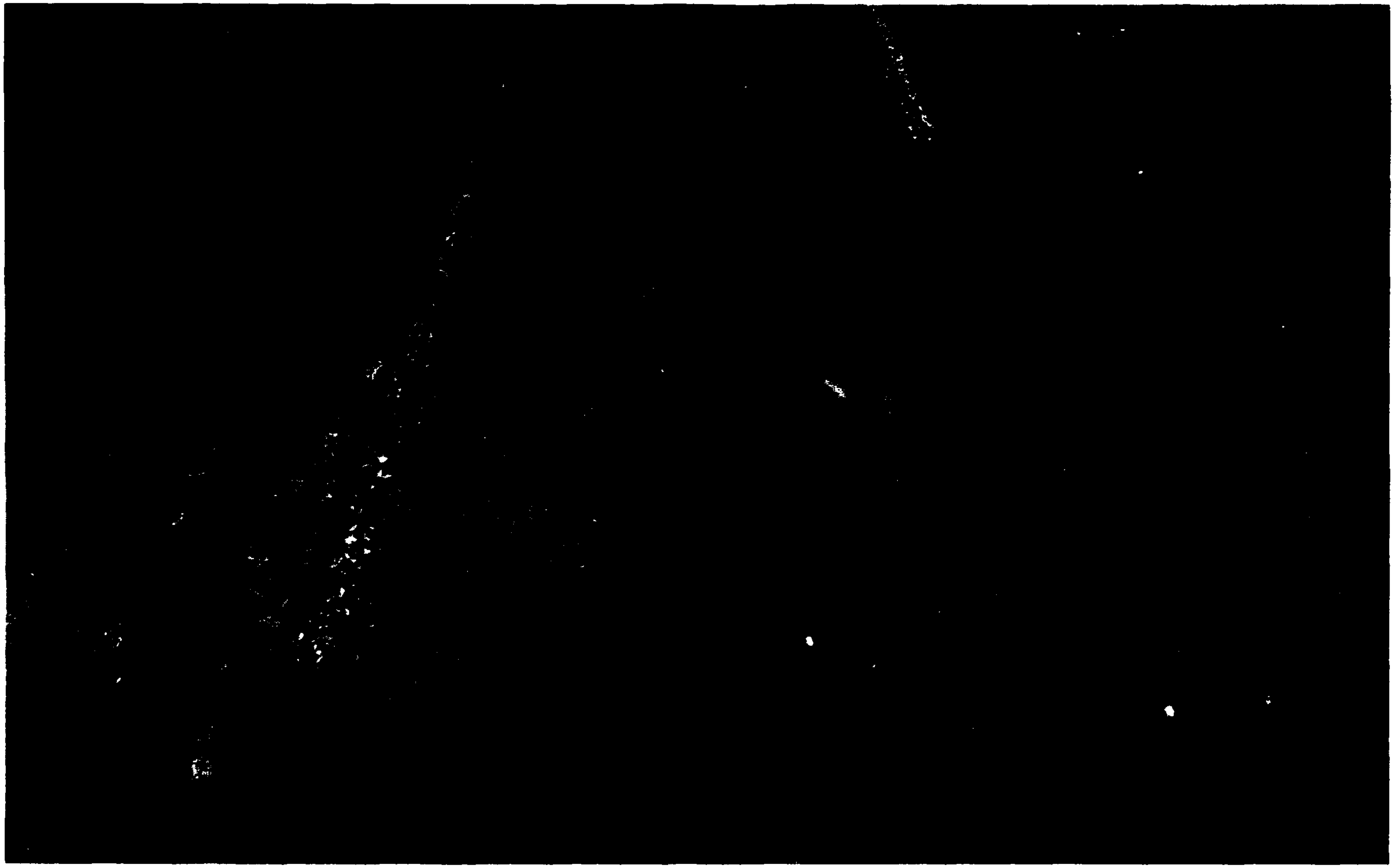

Photo 211. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4; swl = 0.0 ft

Photo 212. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4; swl = 0.0 ft

Photo 213. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4; swl = 0.0 ft

Photo 214. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4; swl = +6.7 ft

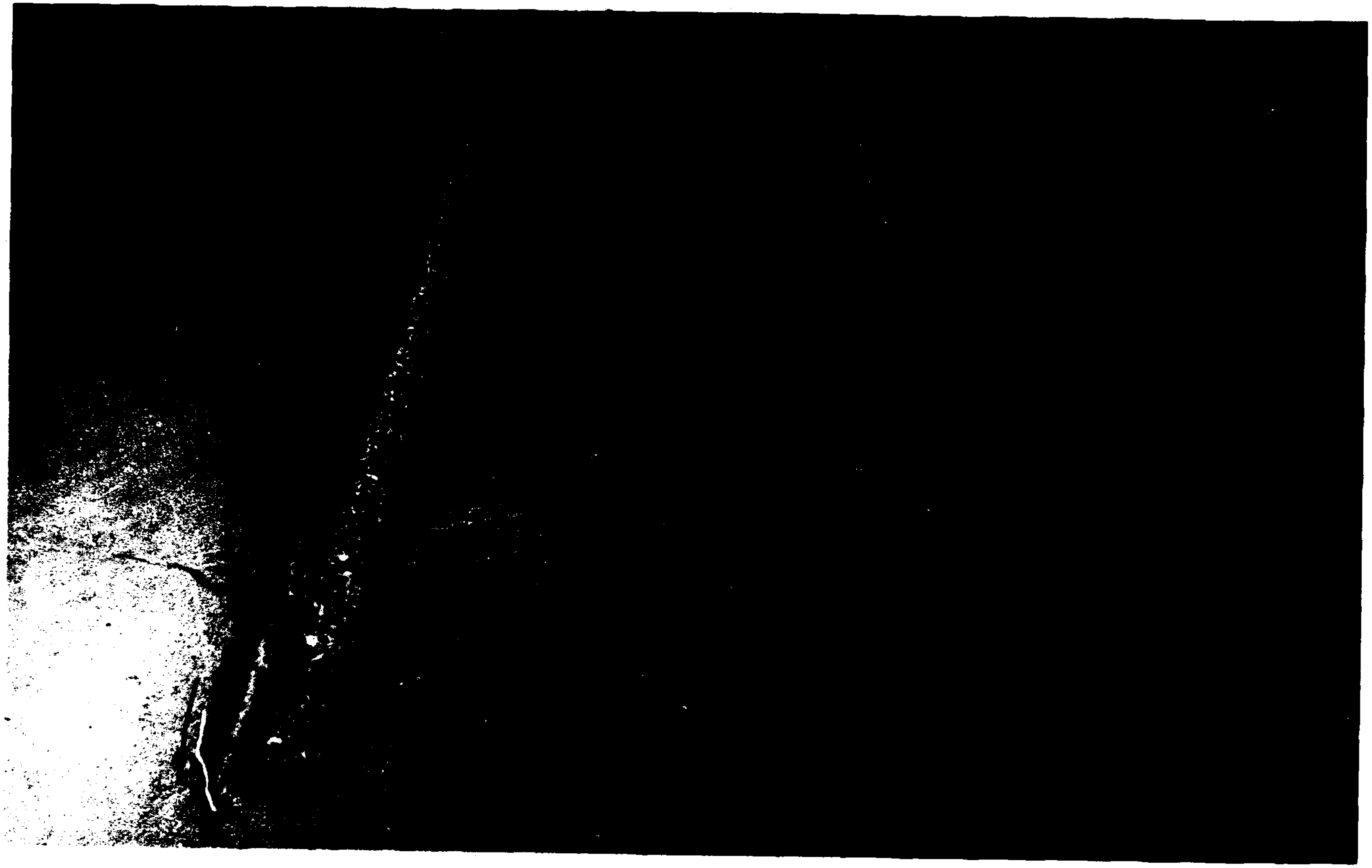

Photo 215. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4; swl = +6.7 ft

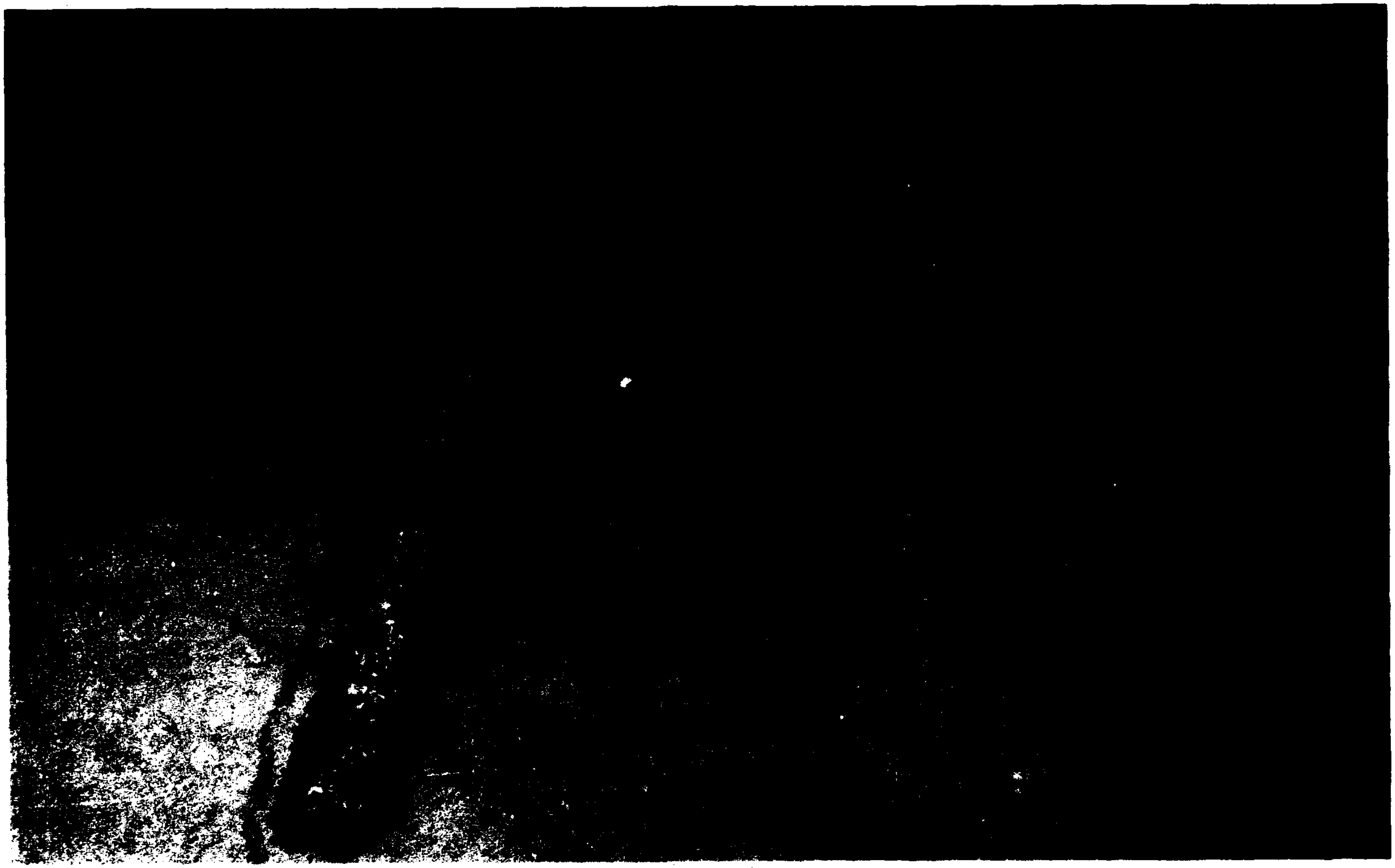

Photo 216. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4; swl = +6.7 ft

Photo 217. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4; swl = +6.7 ft

Photo 218. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 4; 13-sec, 7-ft waves from NNW; swl = +6.7 ft

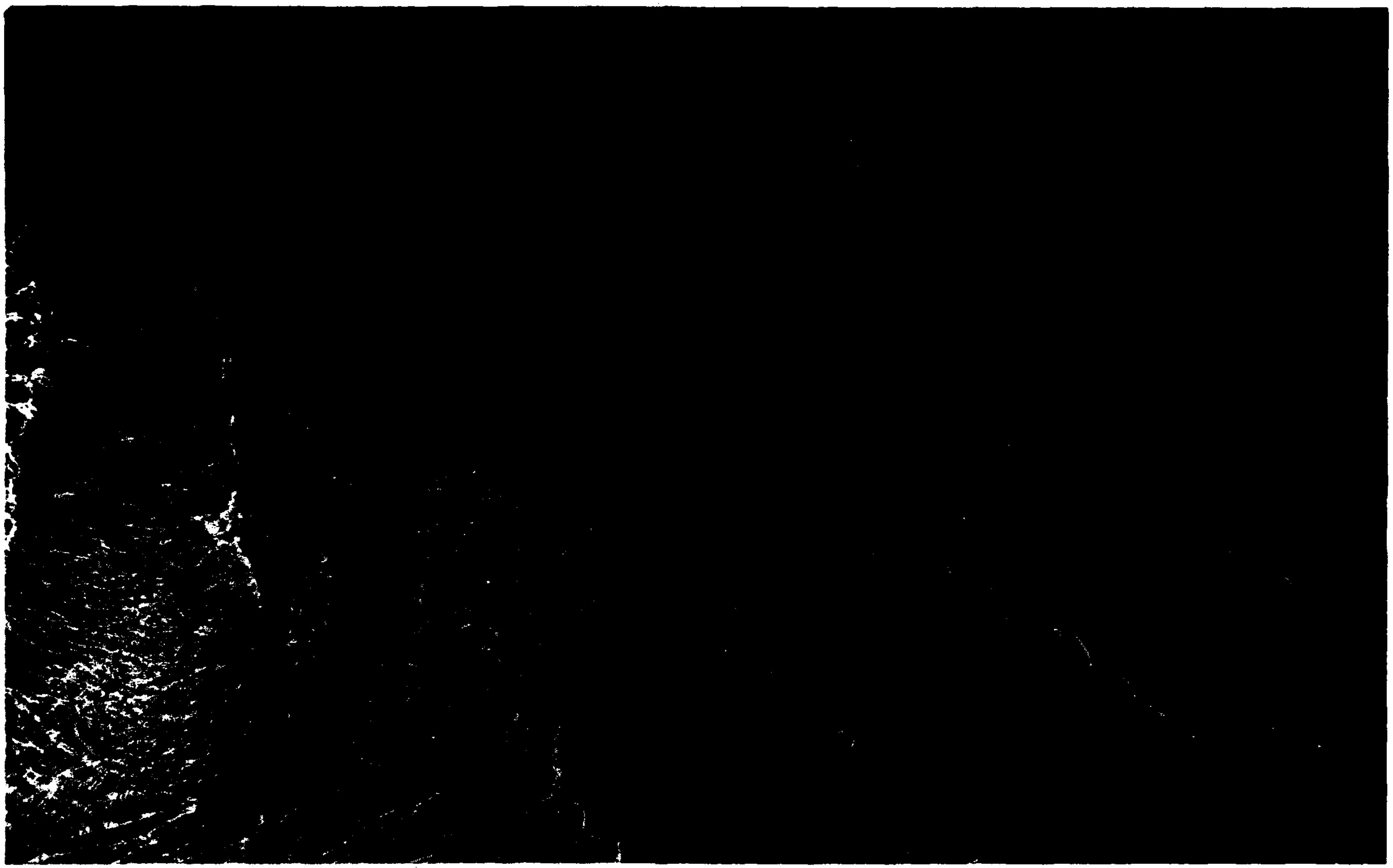

Photo 219. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 4; 15-sec, 17-ft waves from NNW; swl = +6.7 ft

Photo 220. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4A; swl = 0.0 ft

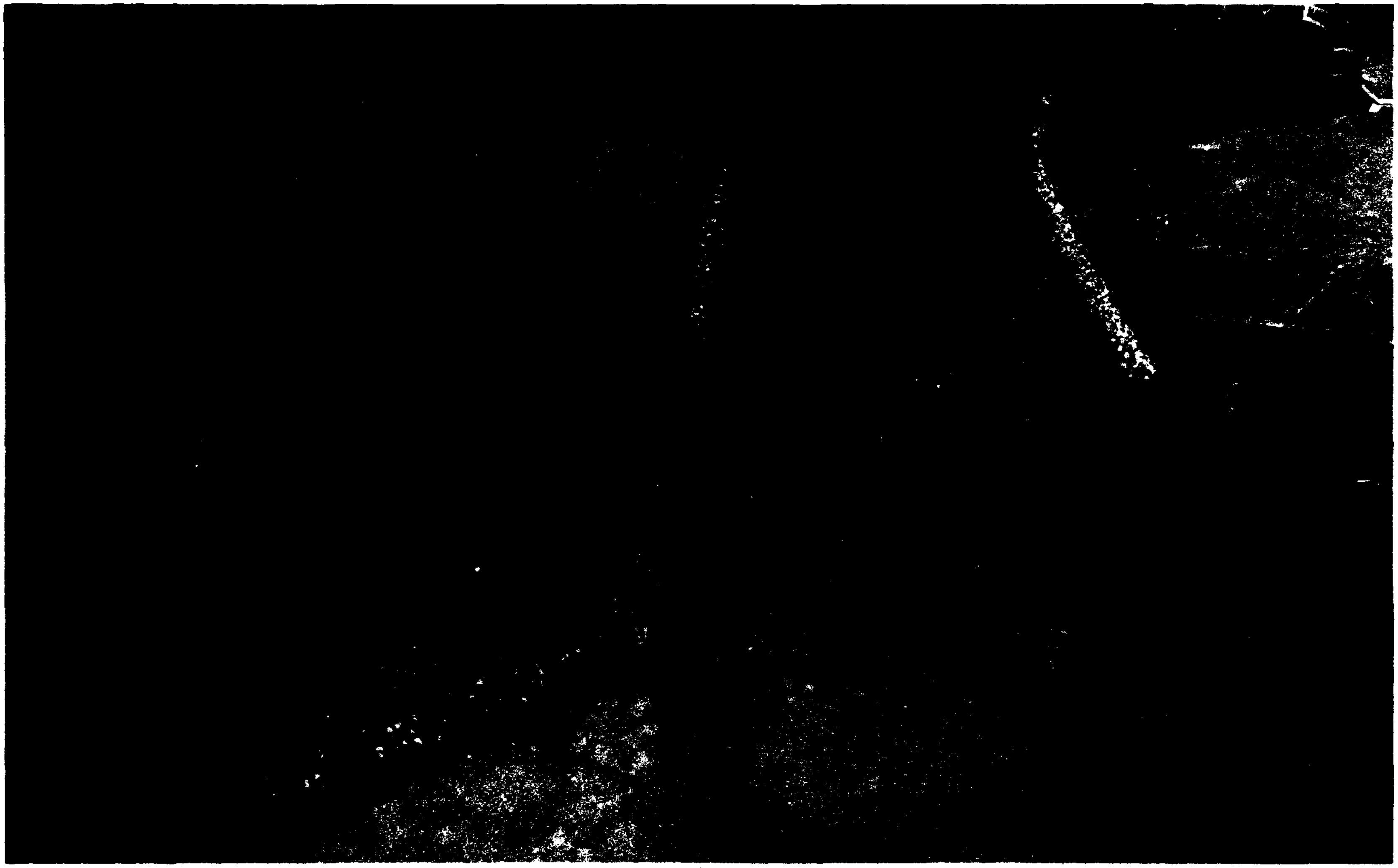

Photo 221. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4A; swl = 0.0 ft

Photo 222. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4A; swl = 0.0 ft

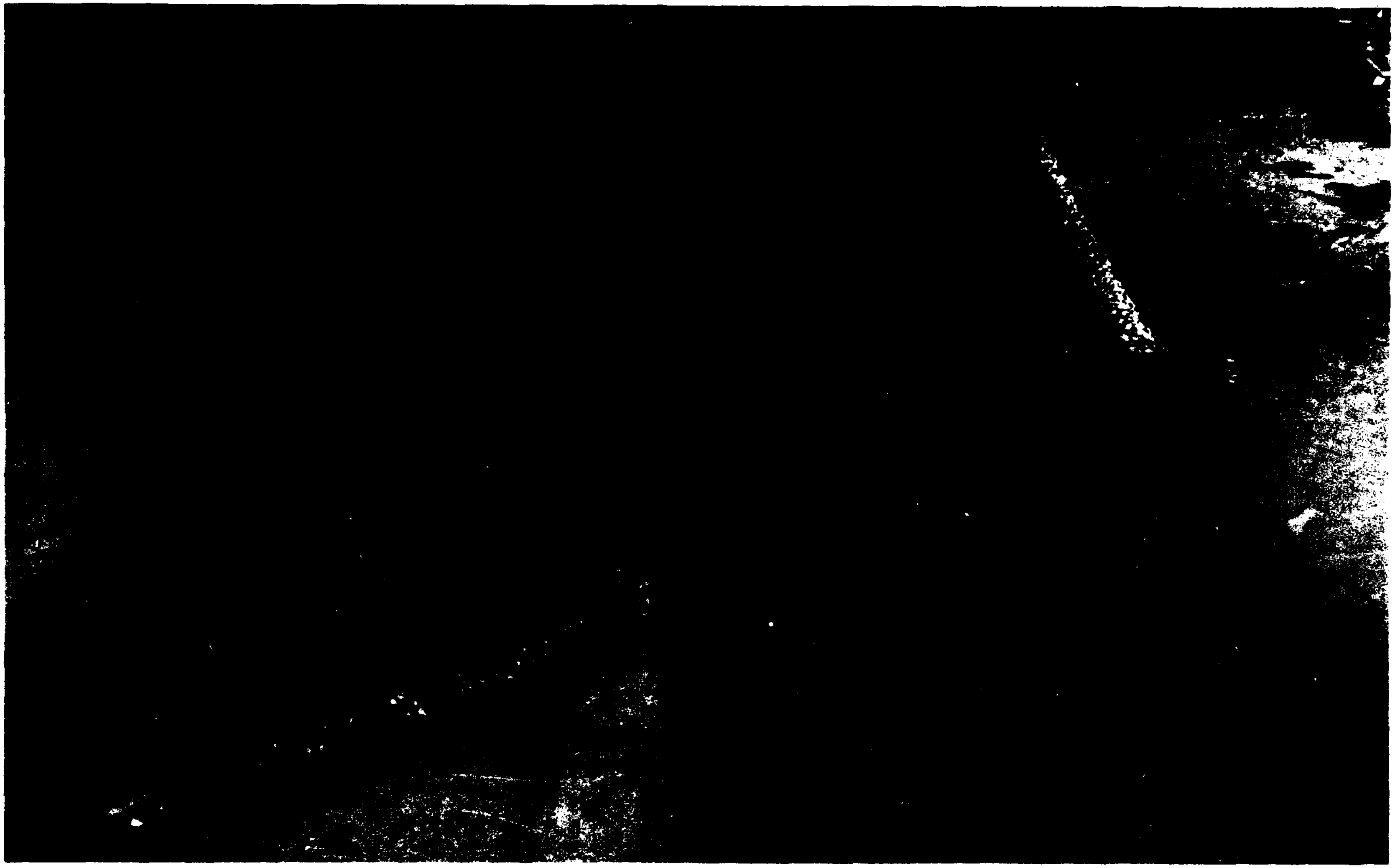

Photo 223. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4A; swl = 0.0 ft

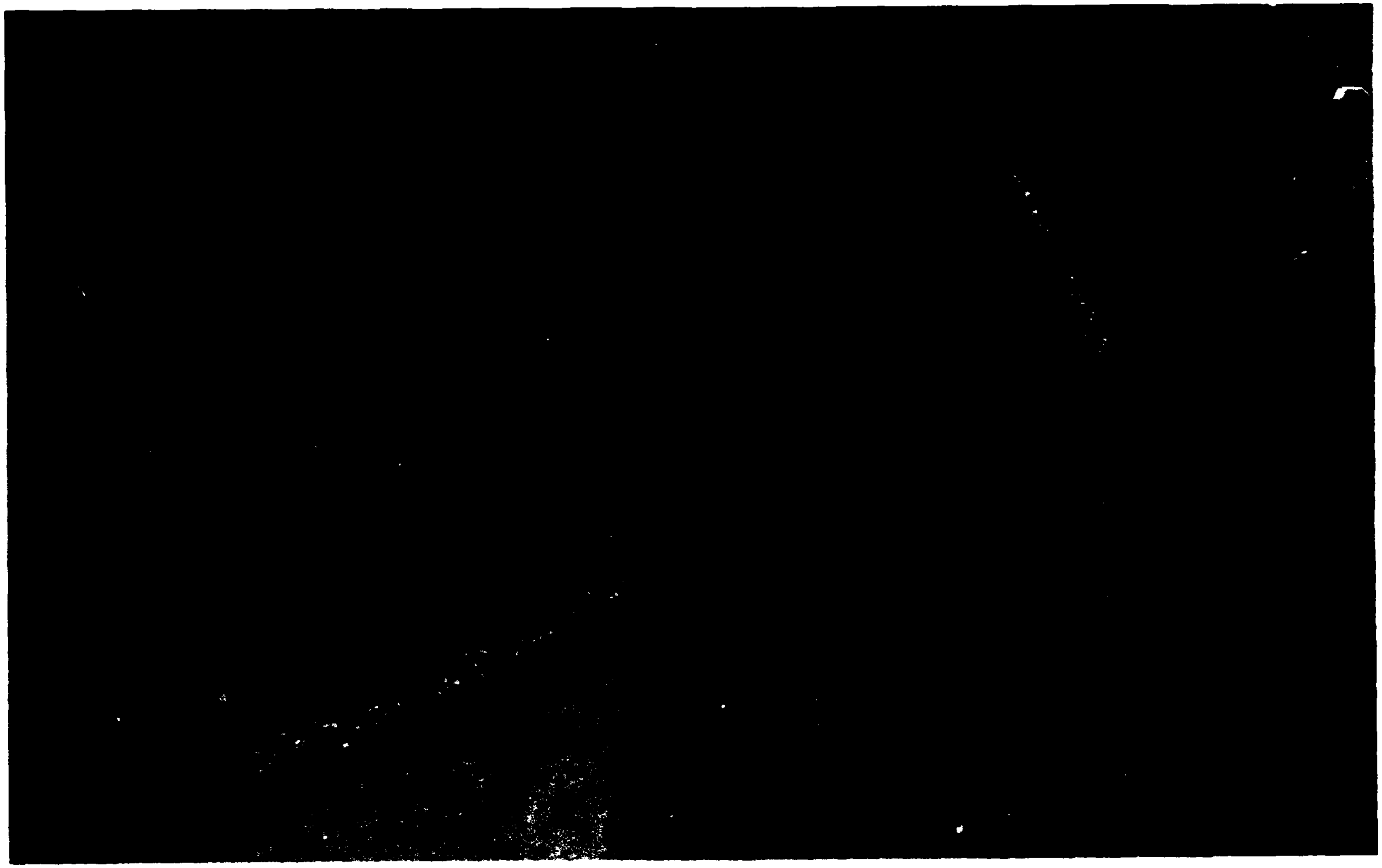

Photo 224. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4A; swl = +6.7 ft

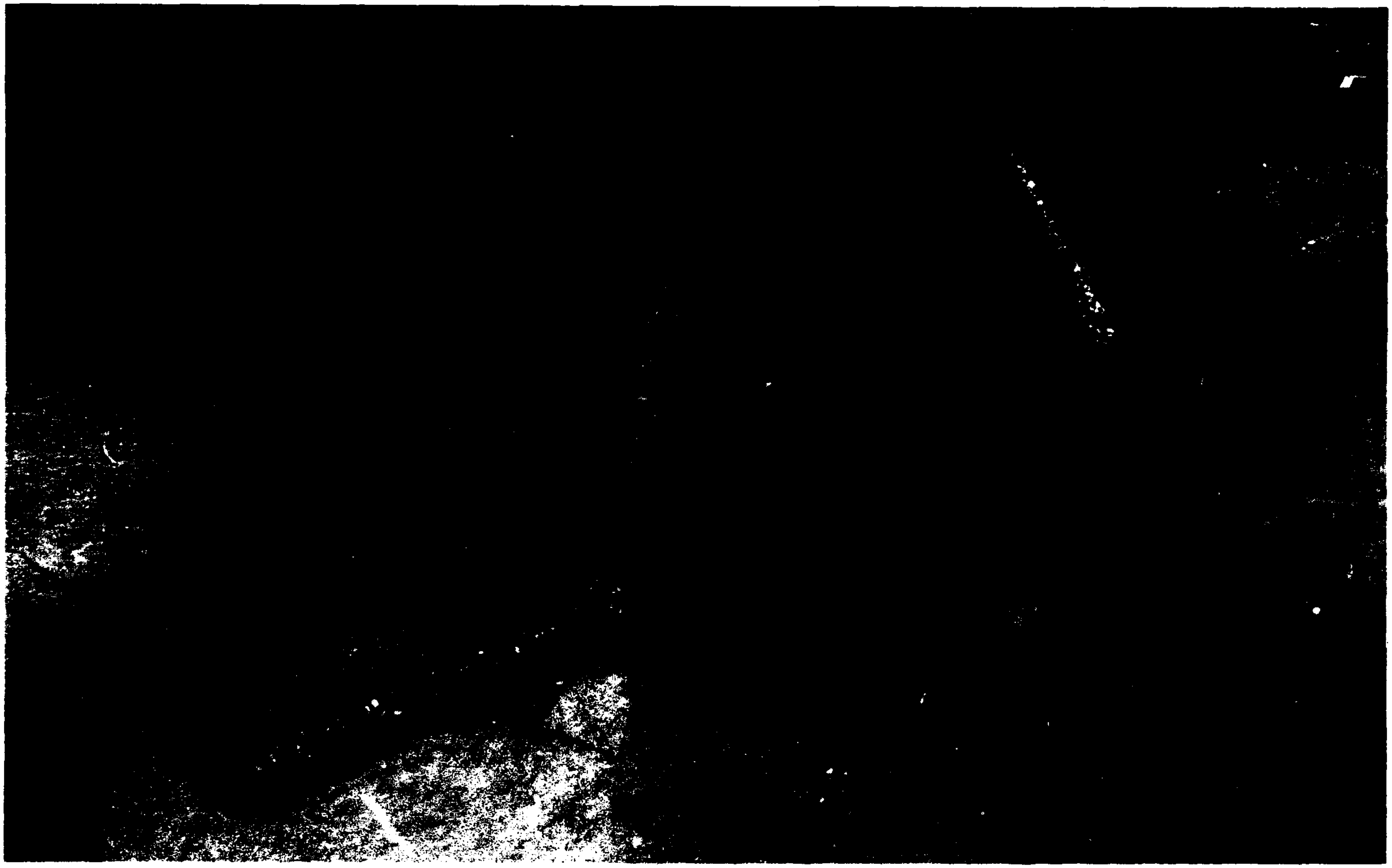

Photo 225. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4A; swl = +6.7 ft

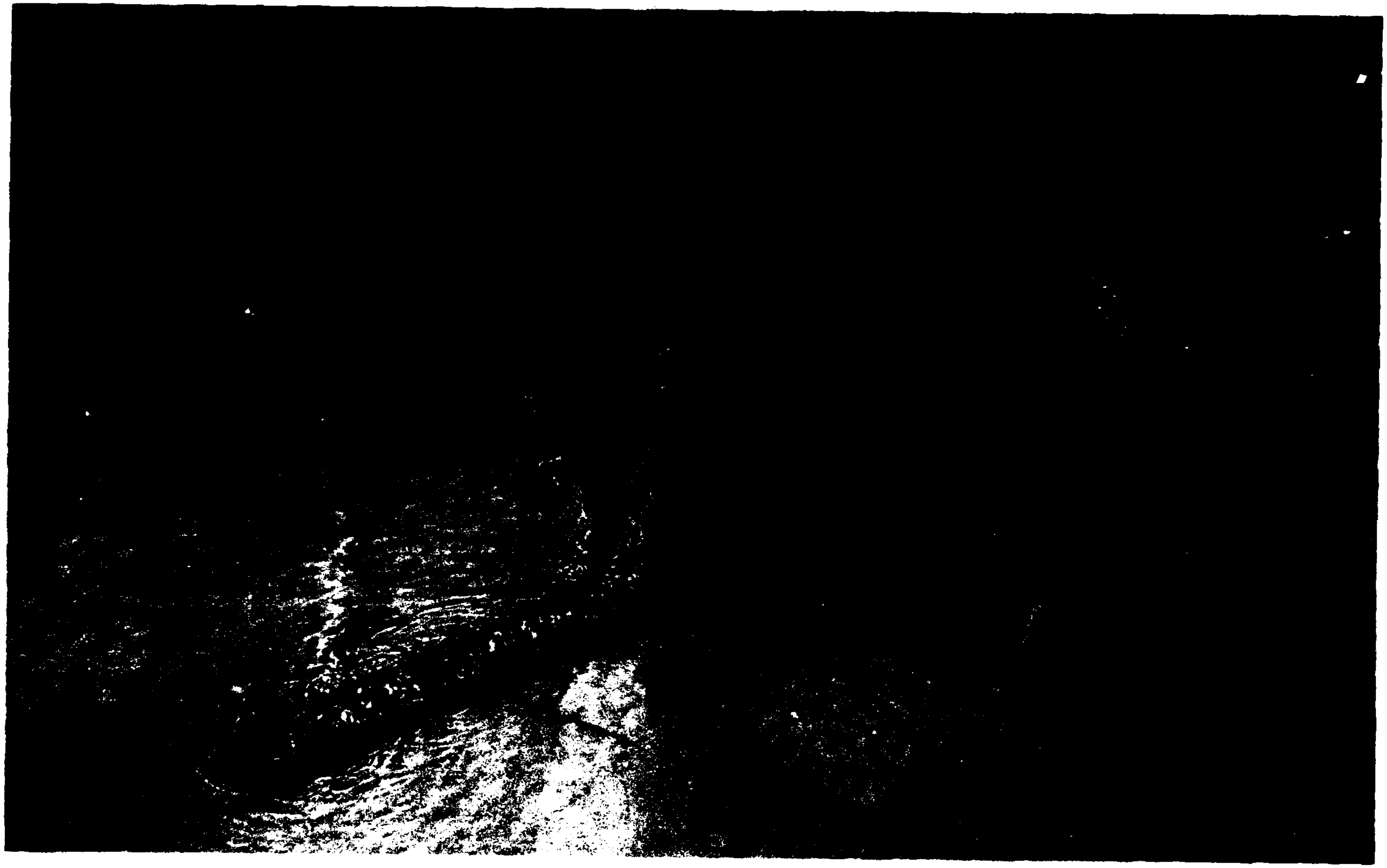

Photo 226. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 4A; 13-sec, 7-ft waves from NNW; swl = +6.7 ft

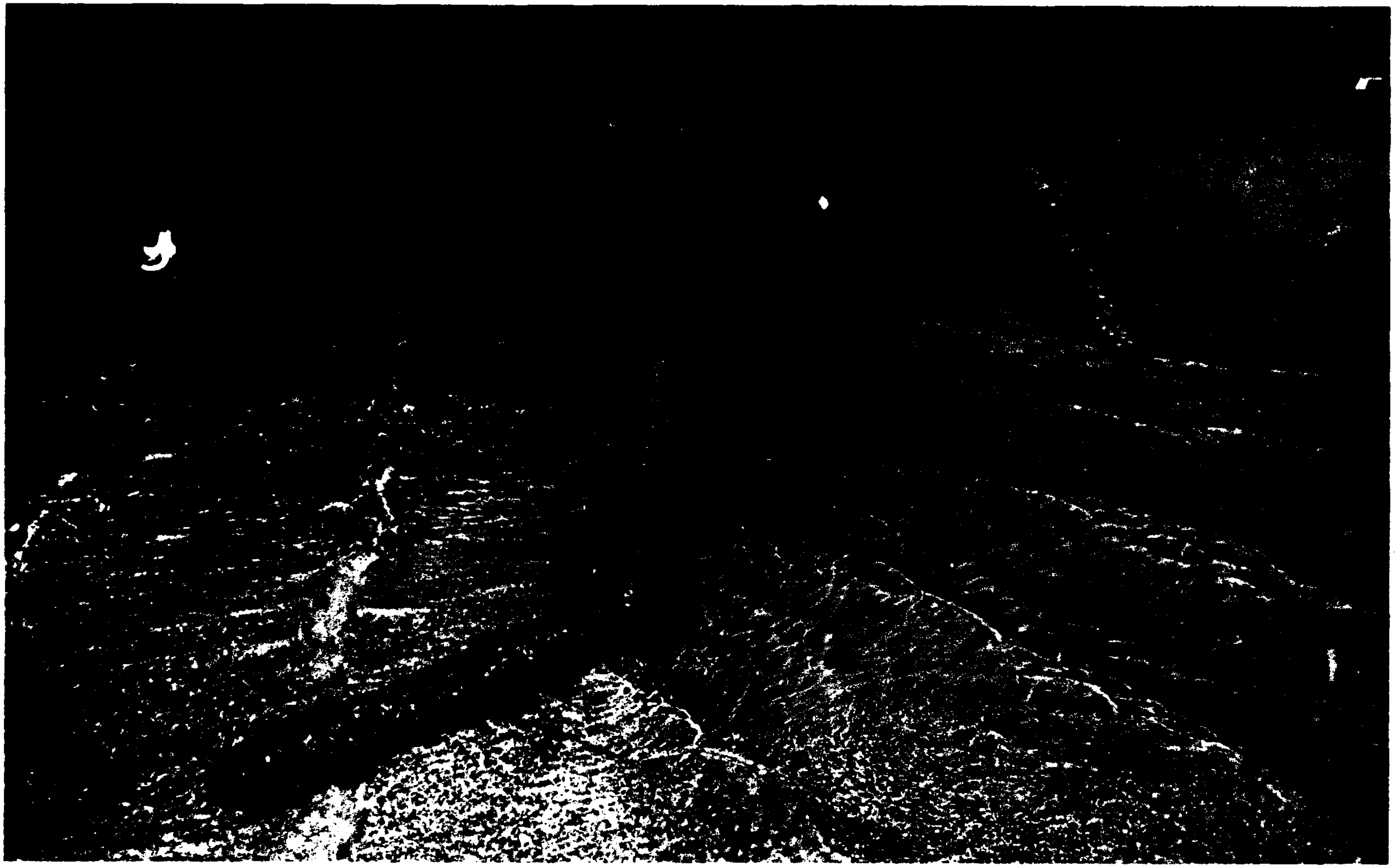

Photo 227. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 4A; 15-sec, 17-ft waves from NNW; swl = +6.7 ft

Photo 228. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4B; swl = +6.7 ft

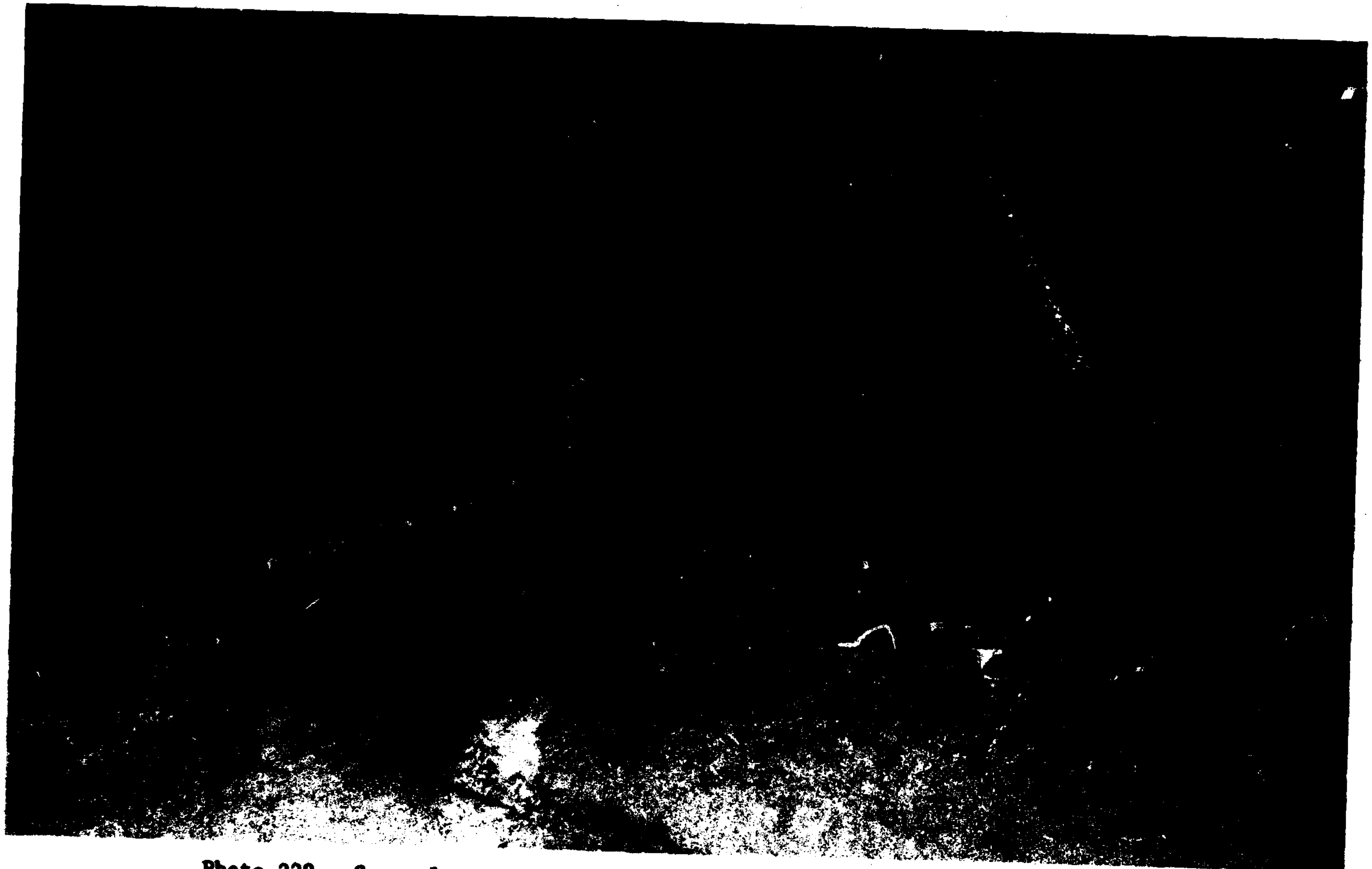

Photo 229. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4B; swl = +6.7 ft

Photo 230. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4C; swl = +6.7 ft

Photo 231. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4C; swl = +6.7 ft

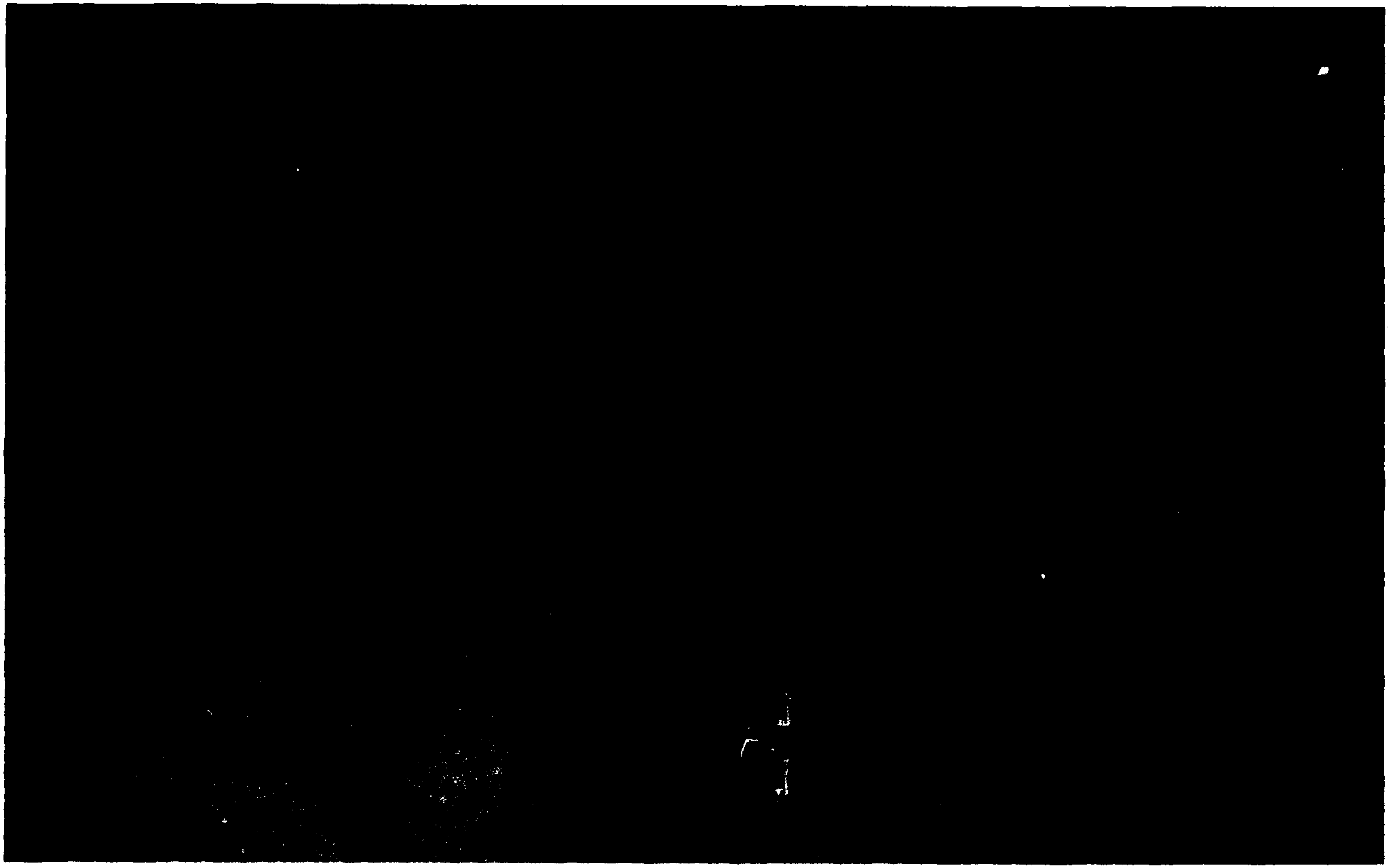

Photo 232. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4C; swl = +6.7 ft

Photo 233. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4C; swl = +6.7 ft

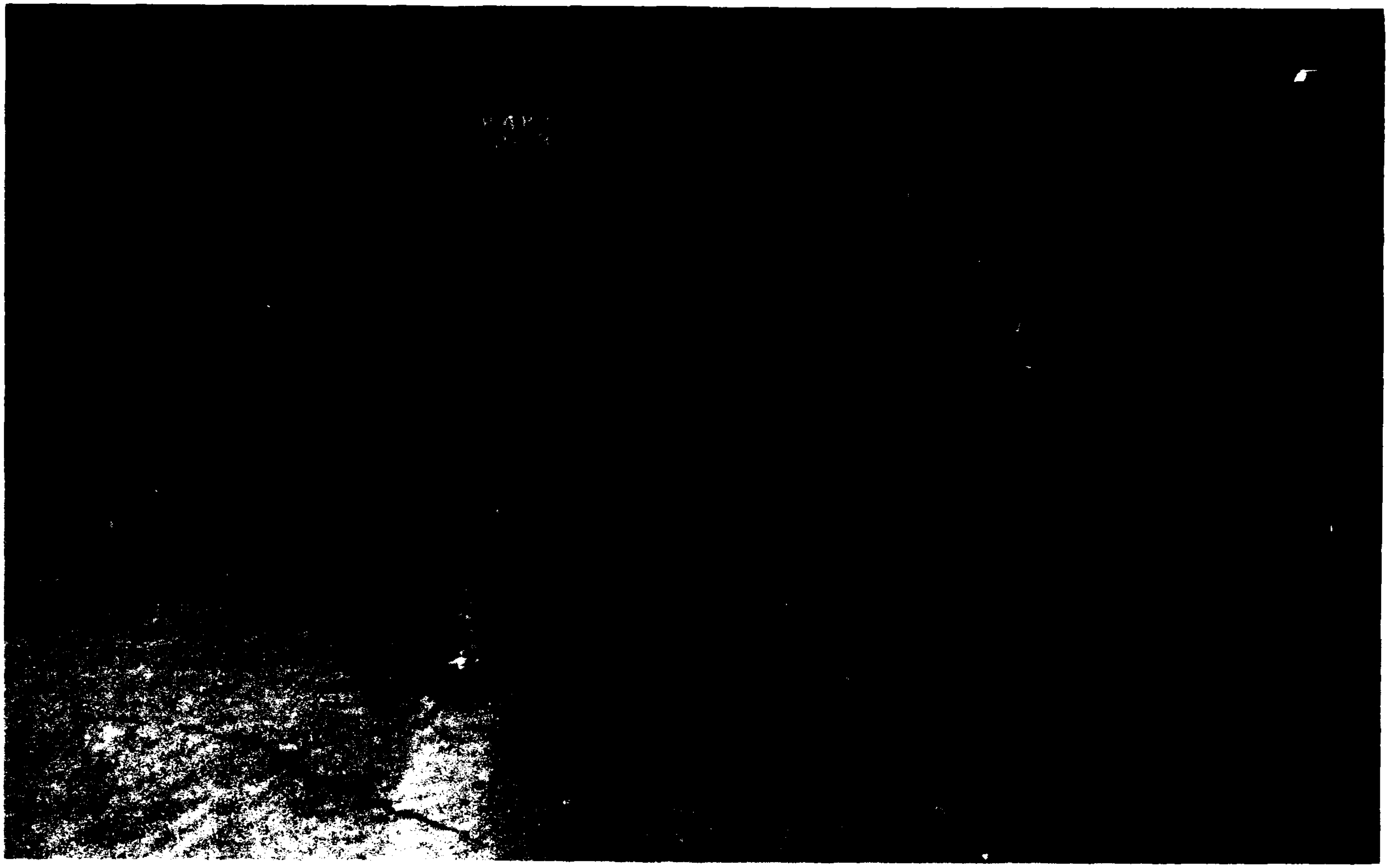

Photo 234. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4D; swl = +6.7 ft

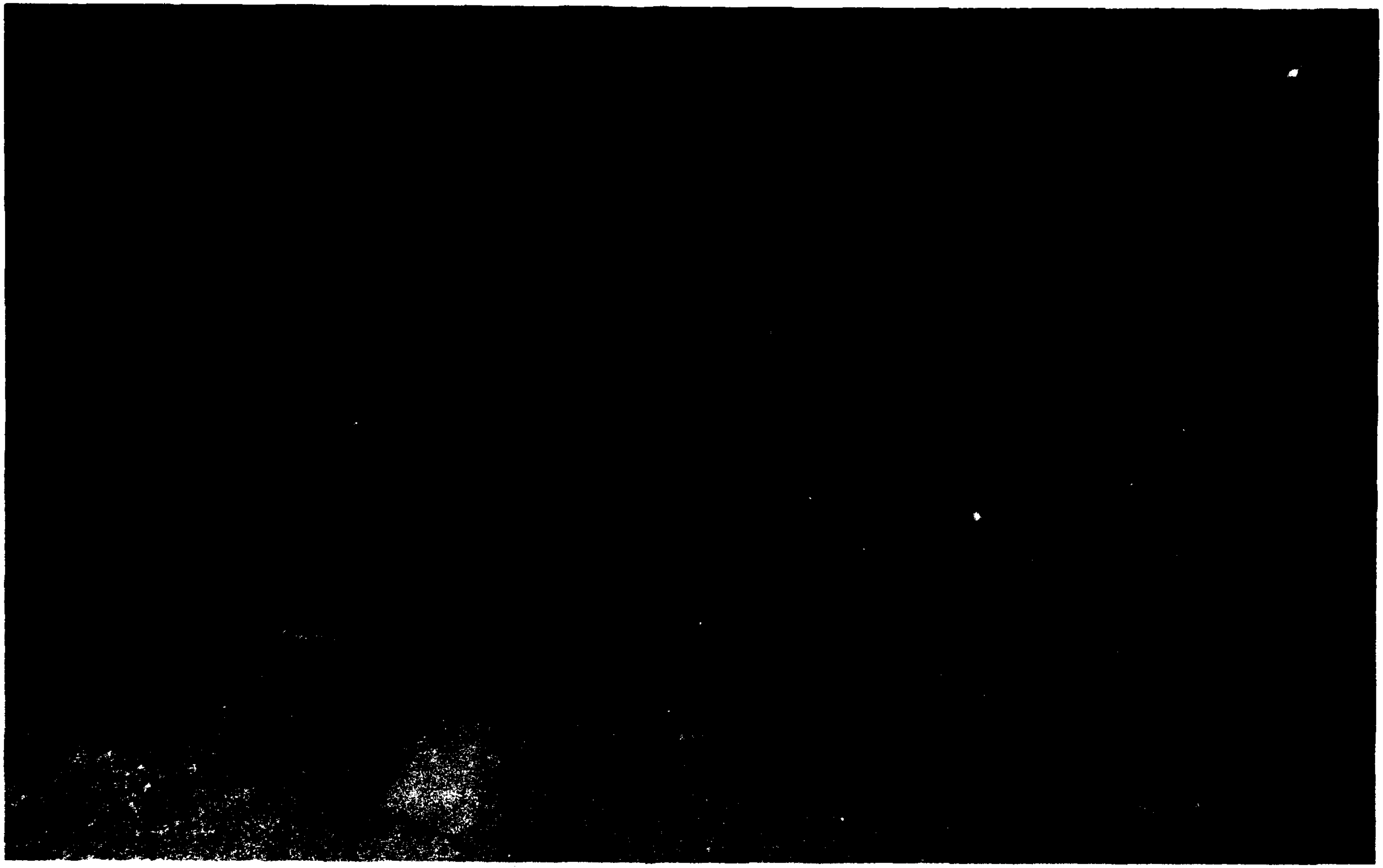

Photo 235. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4D; swl = +6.7 ft

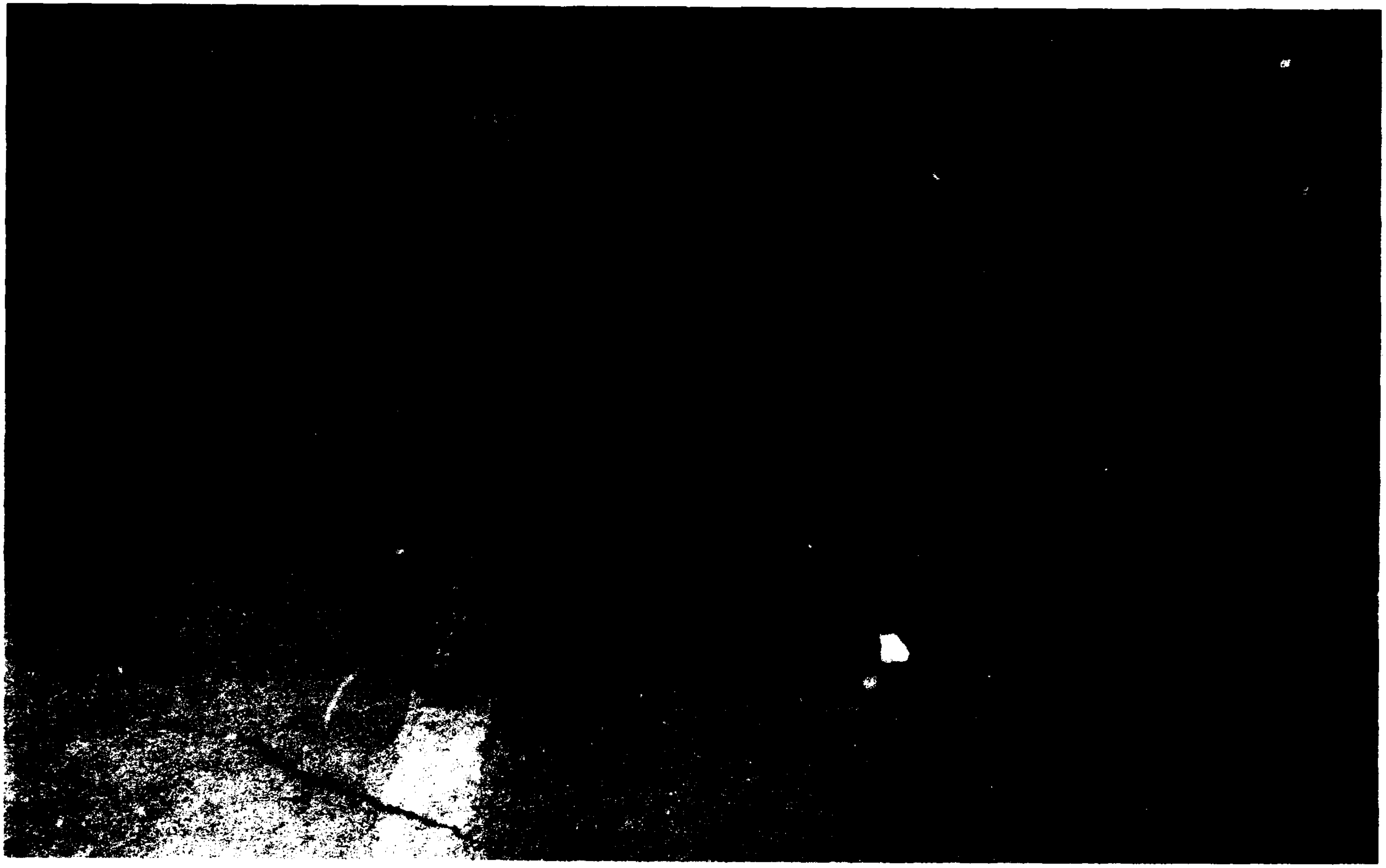

Photo 236. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 4D; swl = +6.7 ft

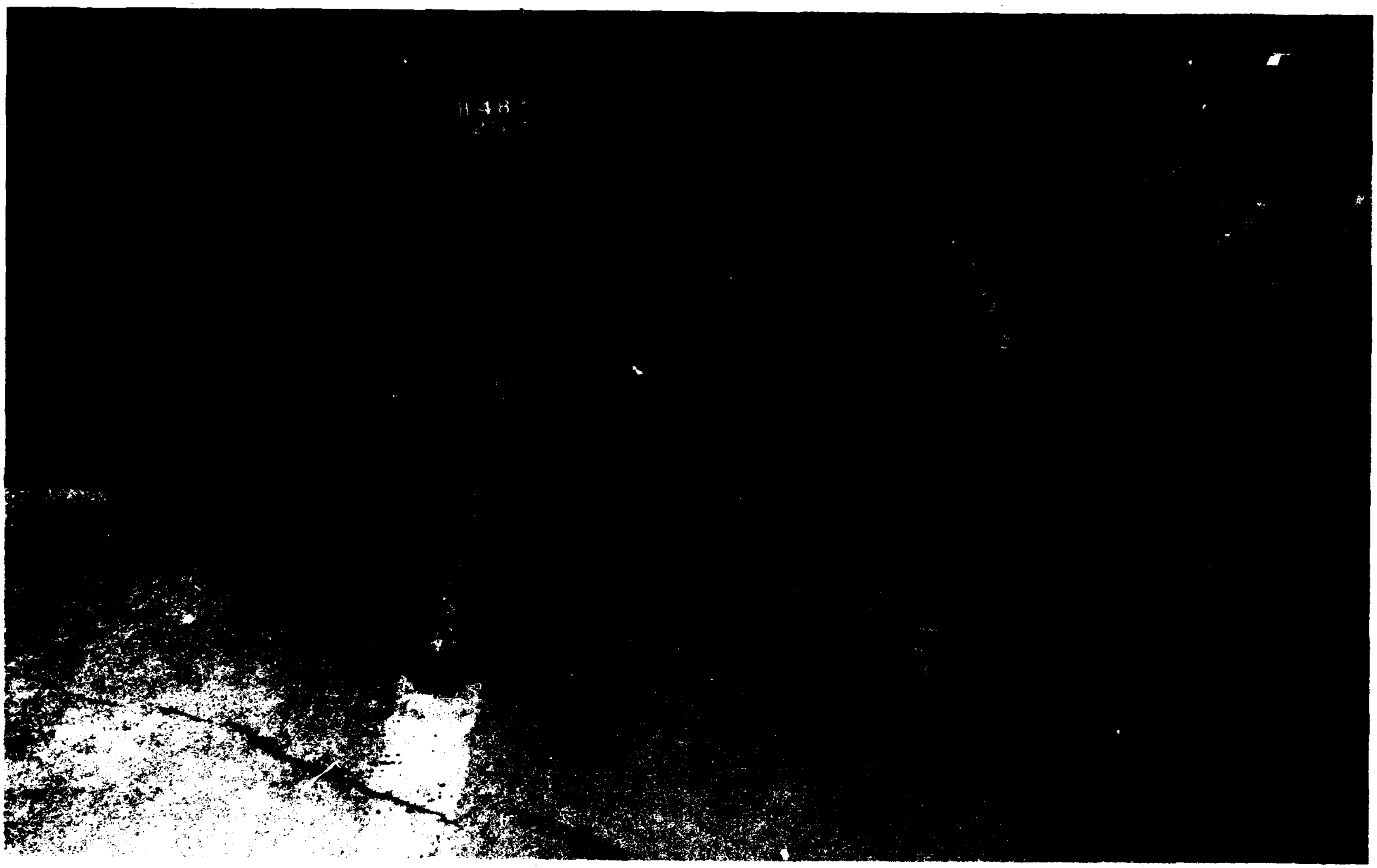

Photo 237. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4D; swl = +6.7 ft

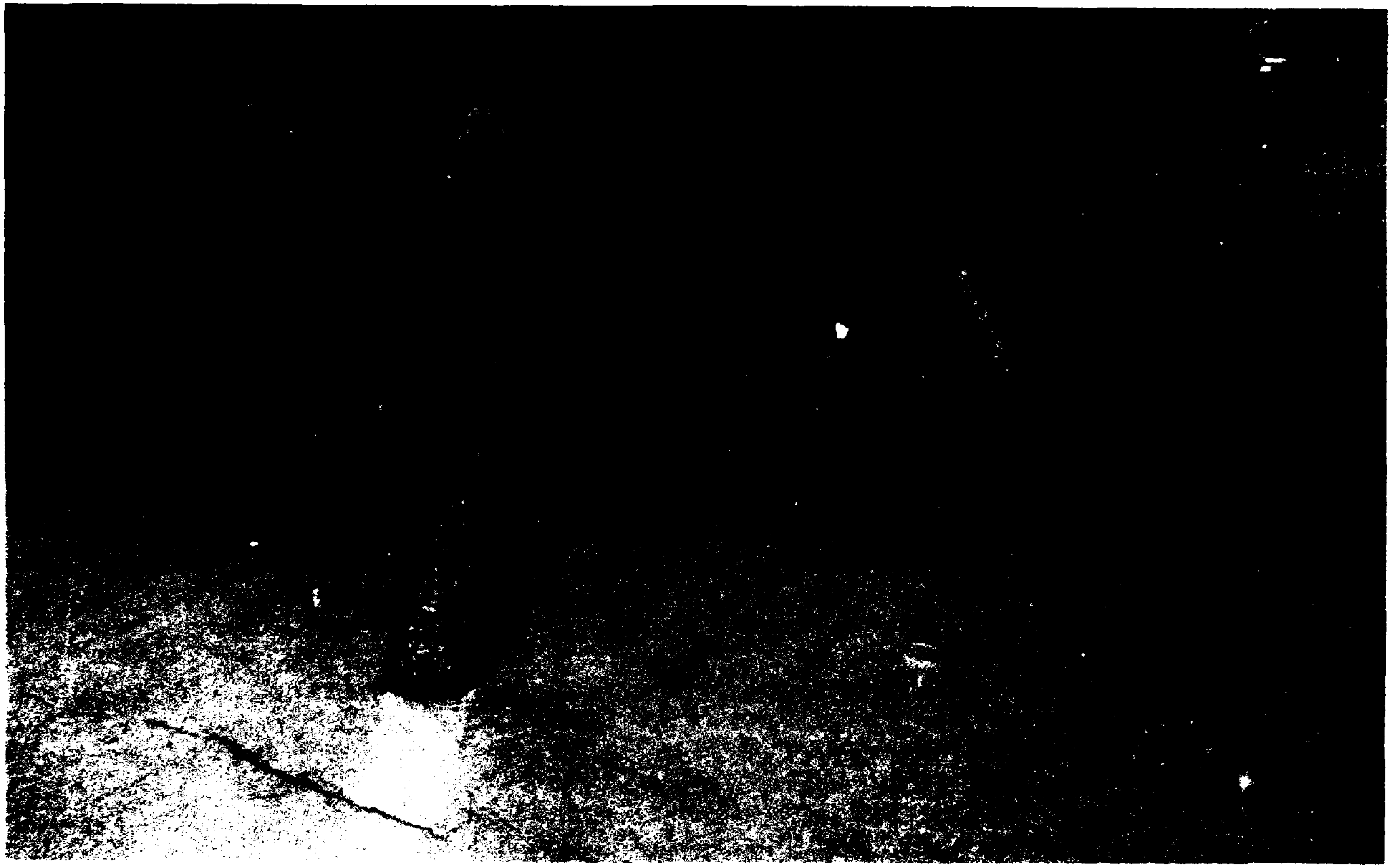

Photo 238. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4E; swl = 0.0 ft

Photo 239. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4E, swl = 0.0 ft

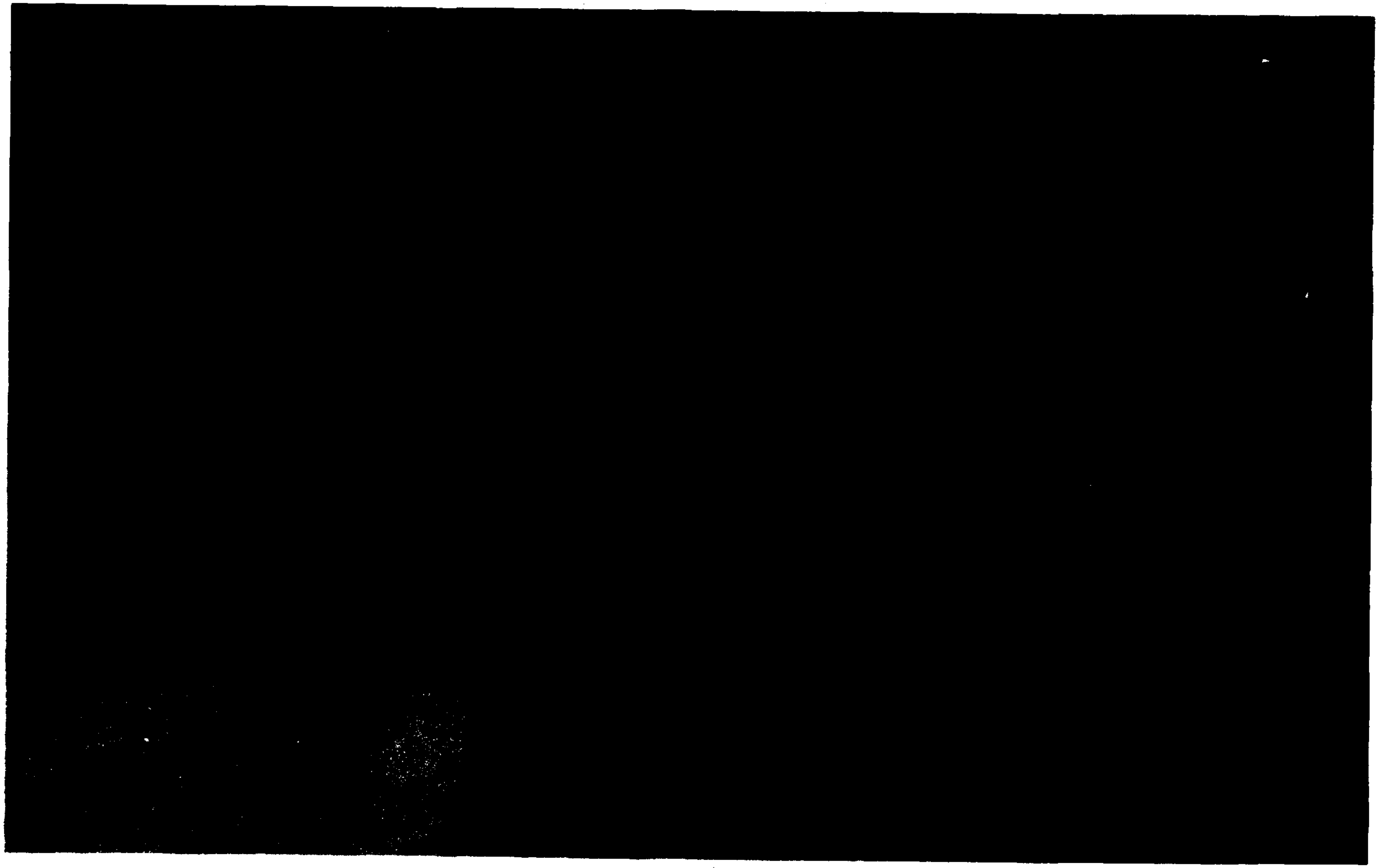

Photo 240. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4E; swl = 0.0 ft

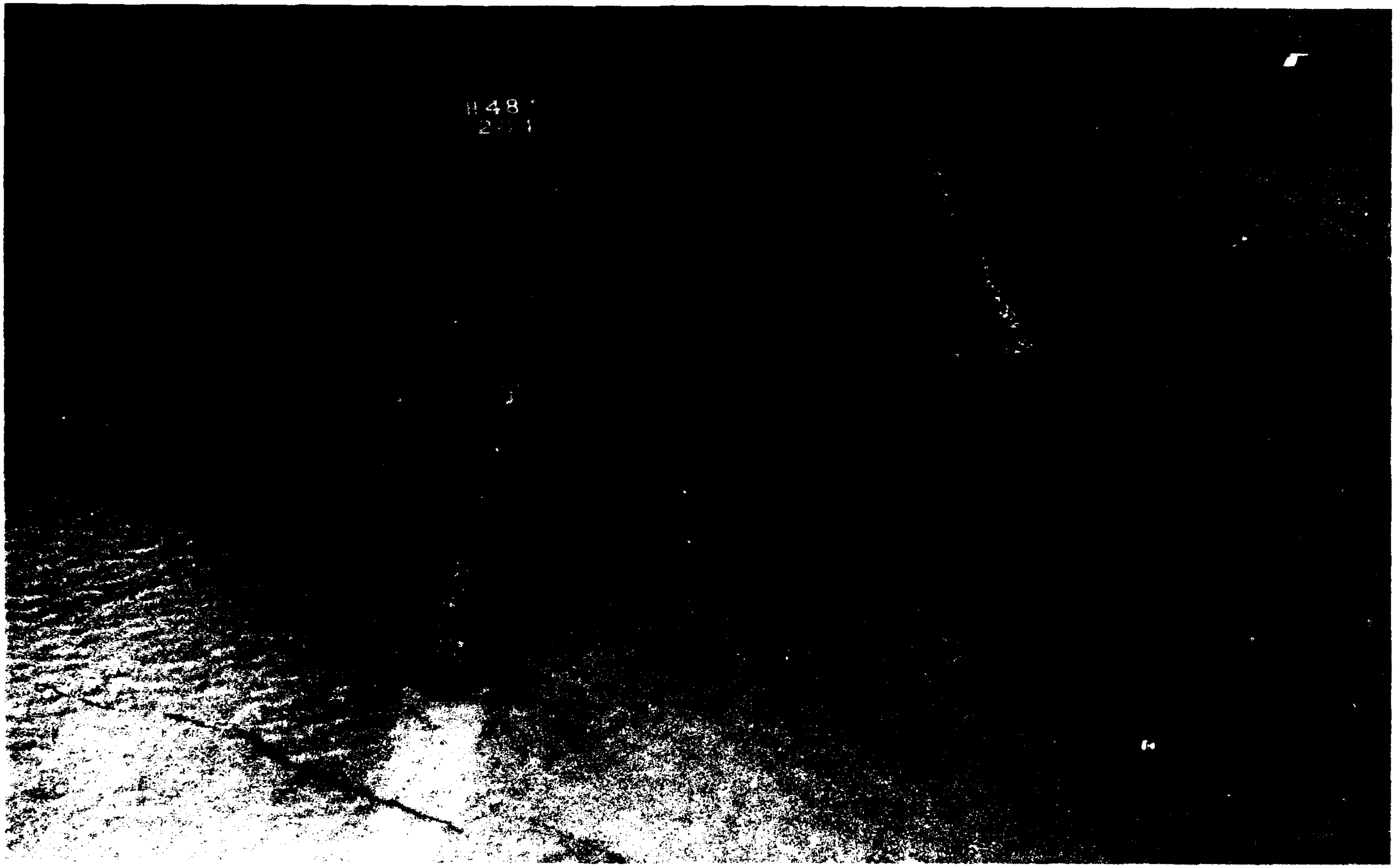

Photo 241. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 4E; swl = +6.7 ft

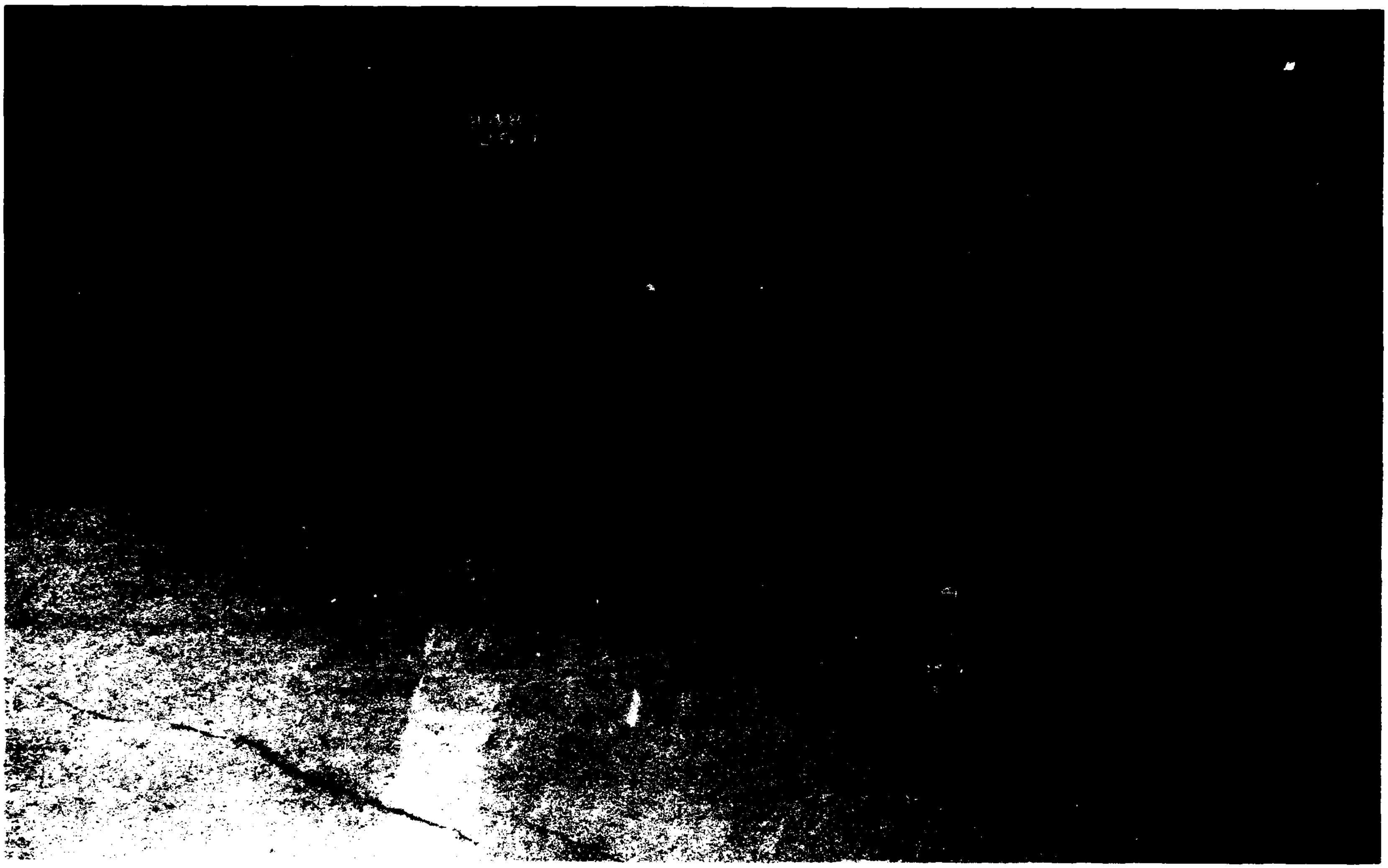

Photo 242. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 4F; swl = +6.7 ft

Photo 243. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4F; swl = +6.7 ft

Photo 244. General movement of tracer material and deposits resulting from 15-sec, 17-ft waves from NNW for Plan 4G; swl = +6.7 ft

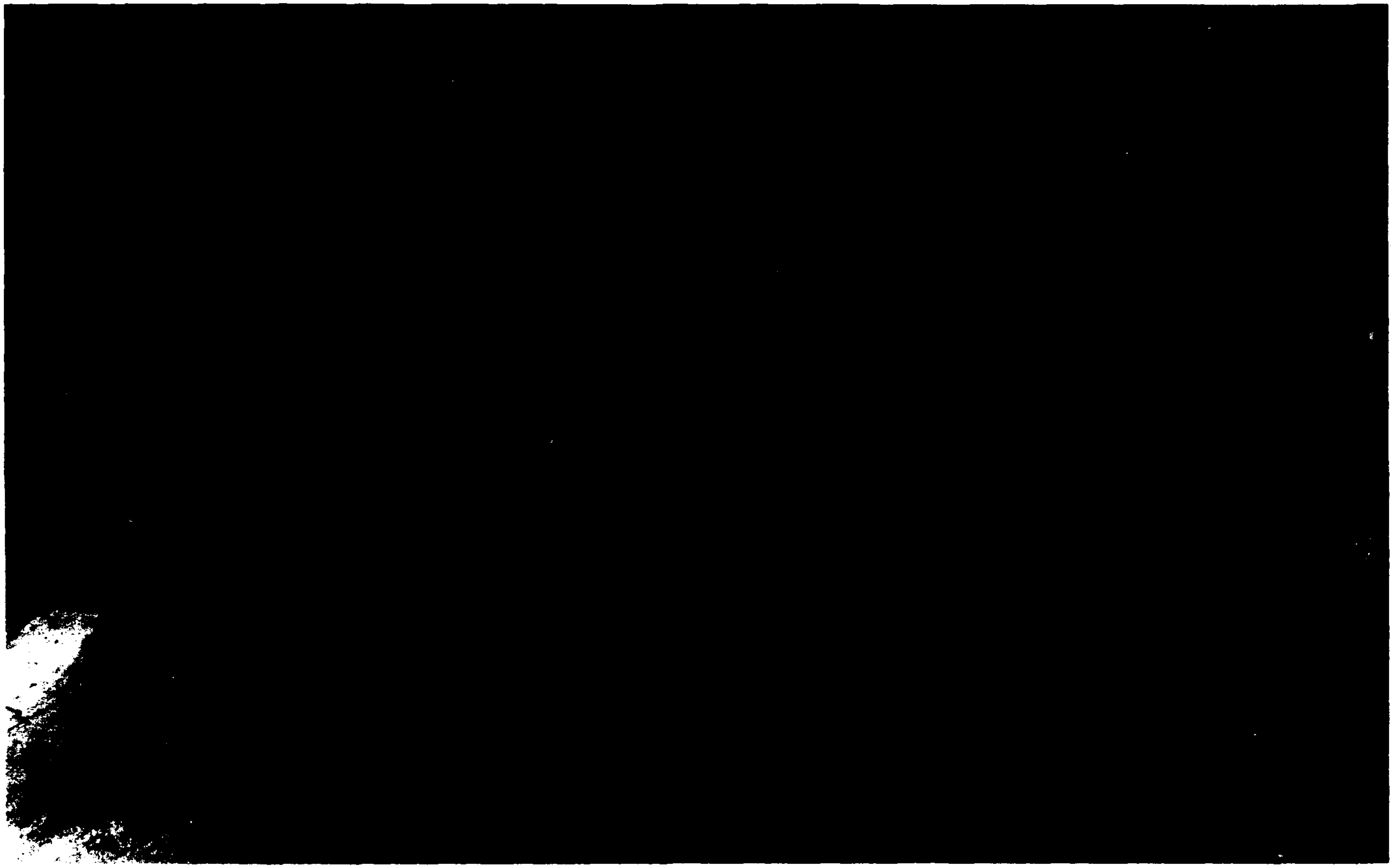

Photo 245. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 5; swl = +6.7 ft

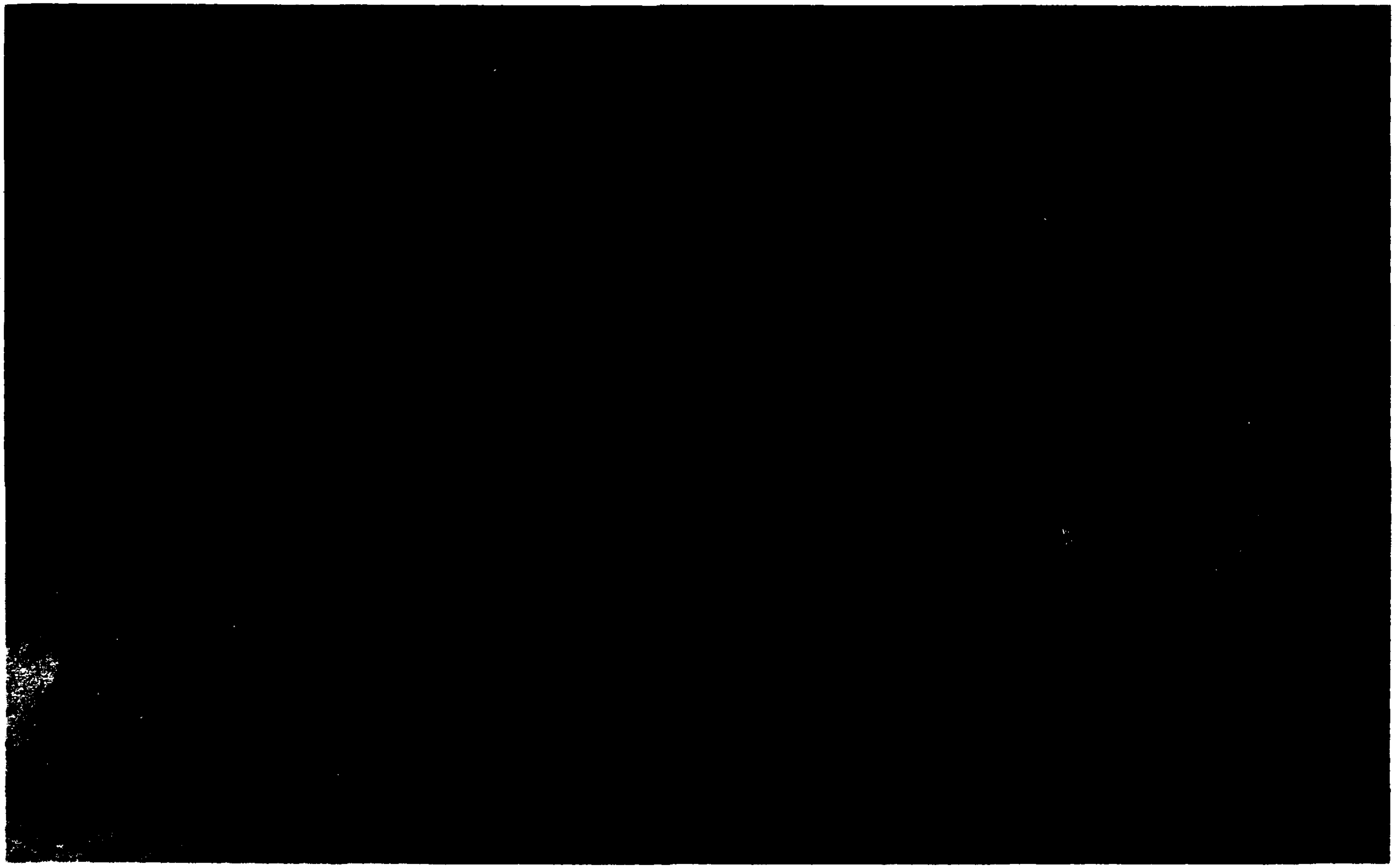

Photo 246. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5; swl = +6.7 ft

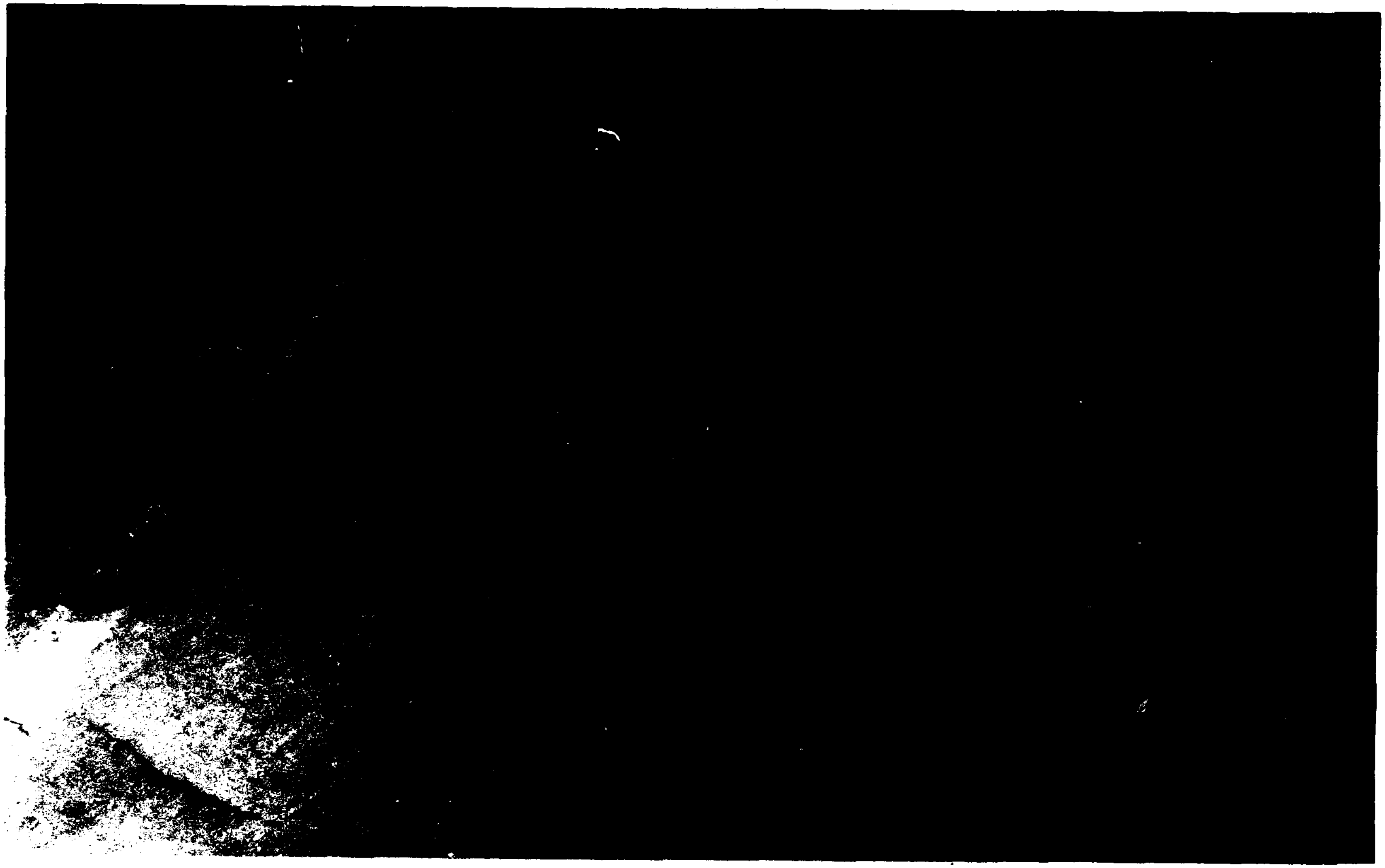

Photo 247. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 5; swl = +6.7 ft

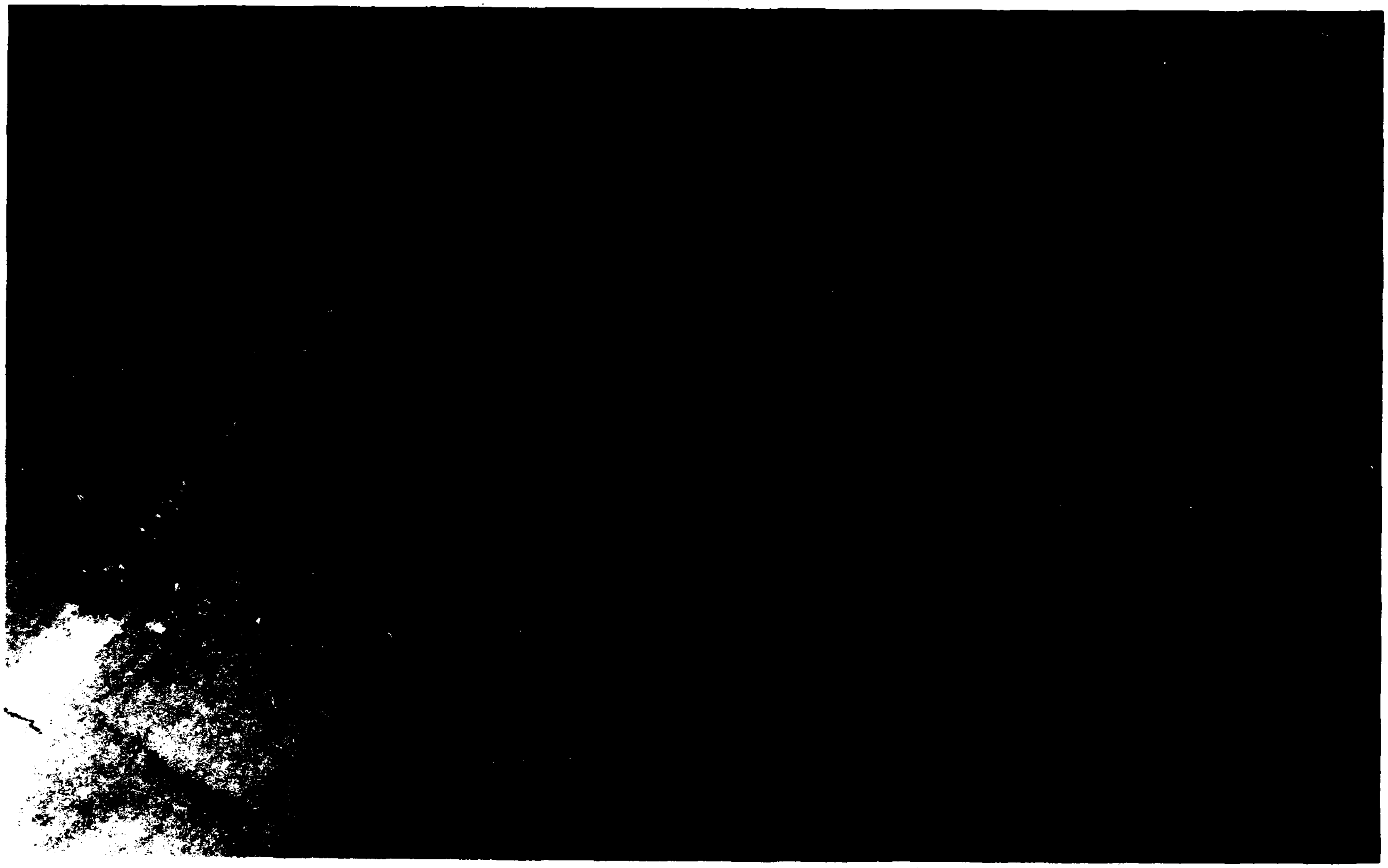

Photo 248. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 5; swl = 0.0 ft

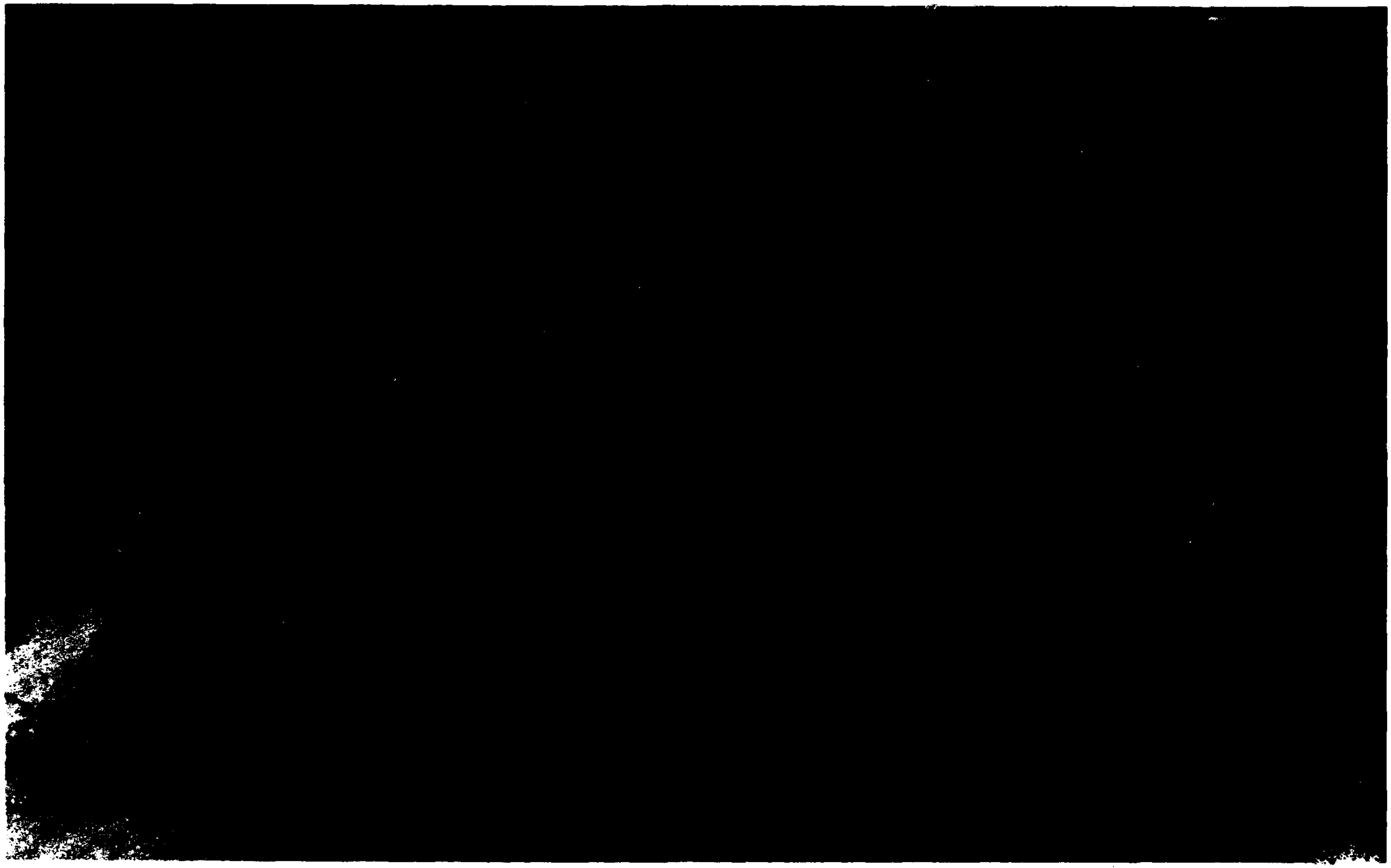

Photo 249. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5; swl = 0.0 ft

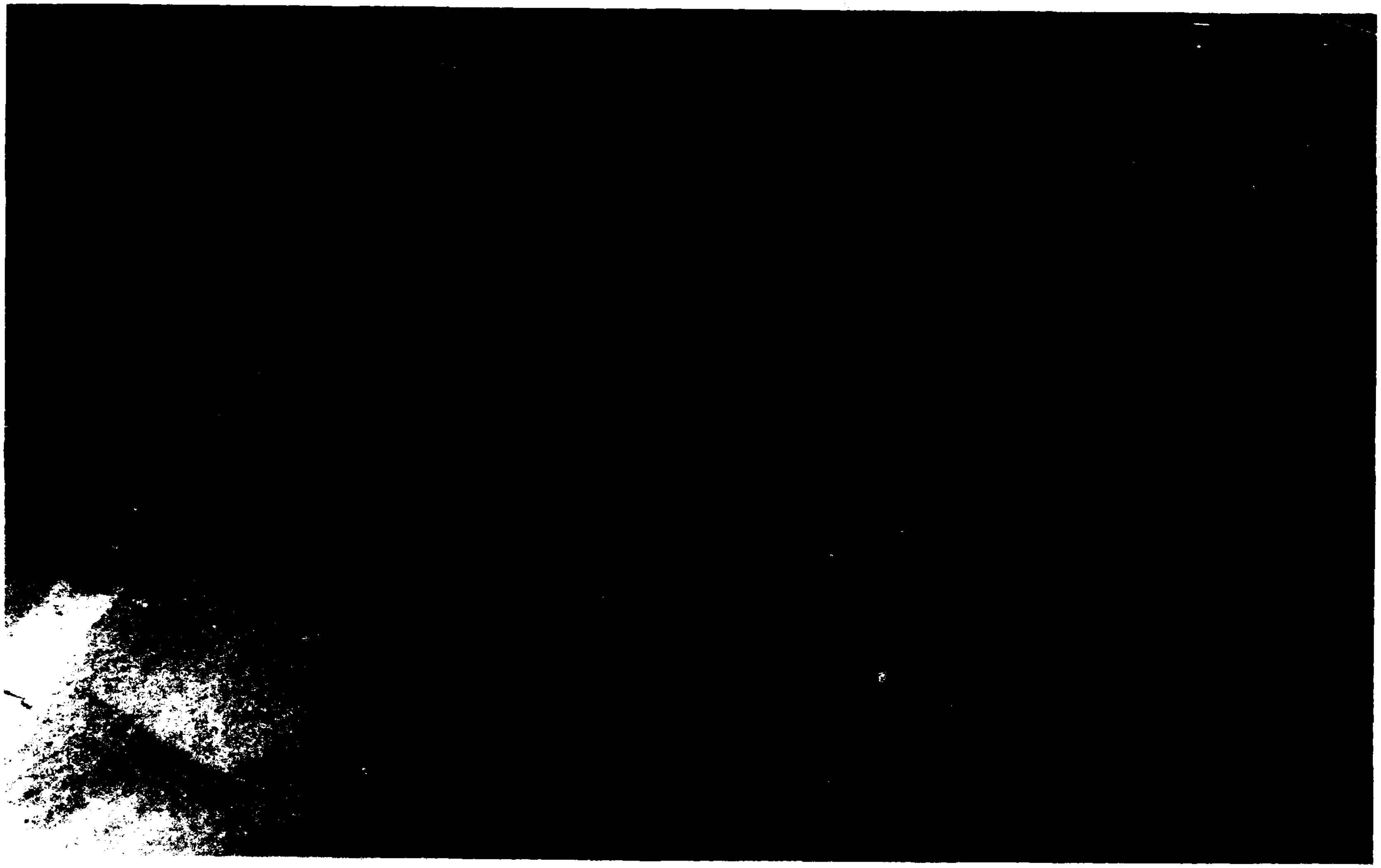

Photo 250. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 5A; swl = +6.7 ft

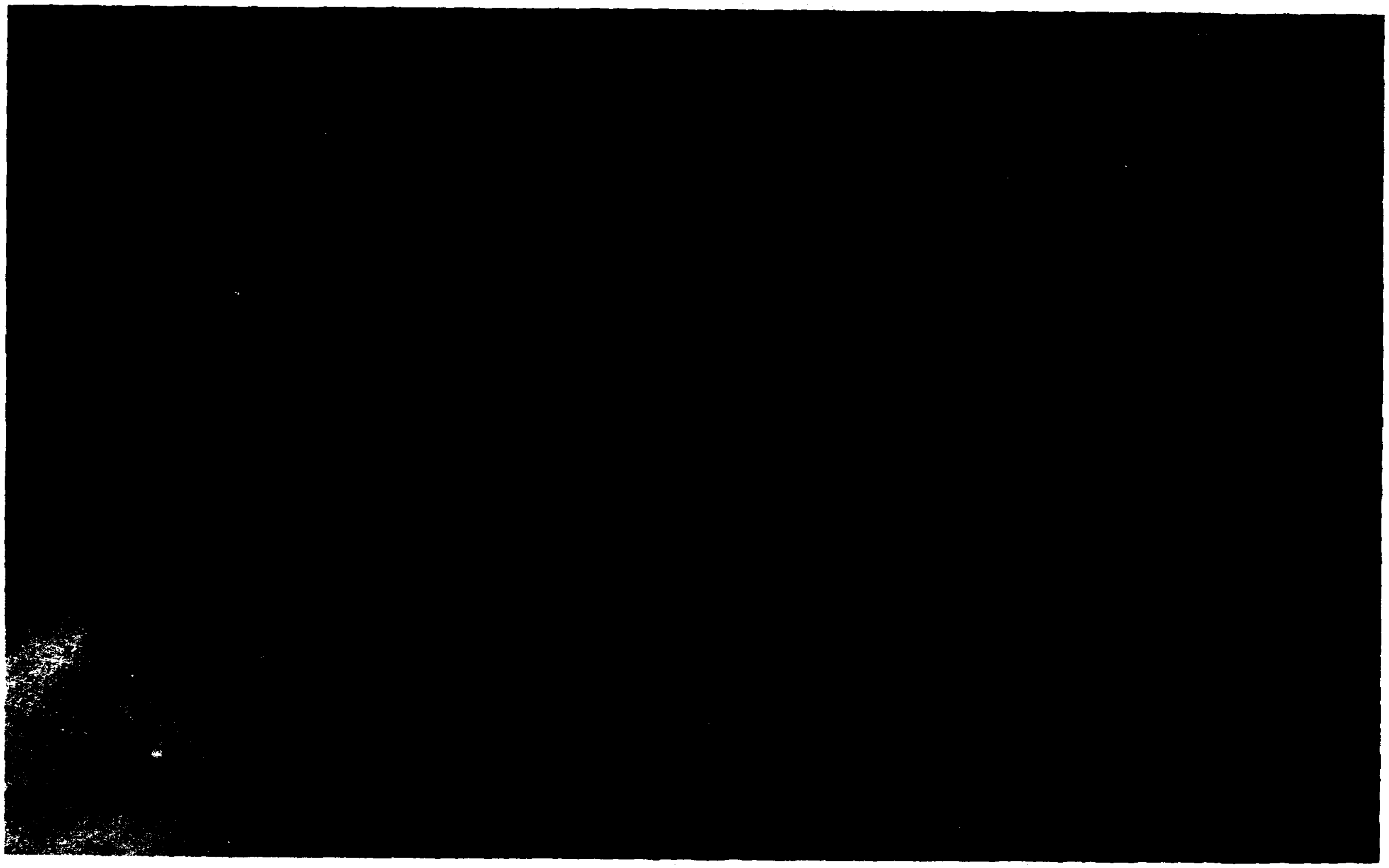

Photo 251. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5A; swl = +6.7 ft

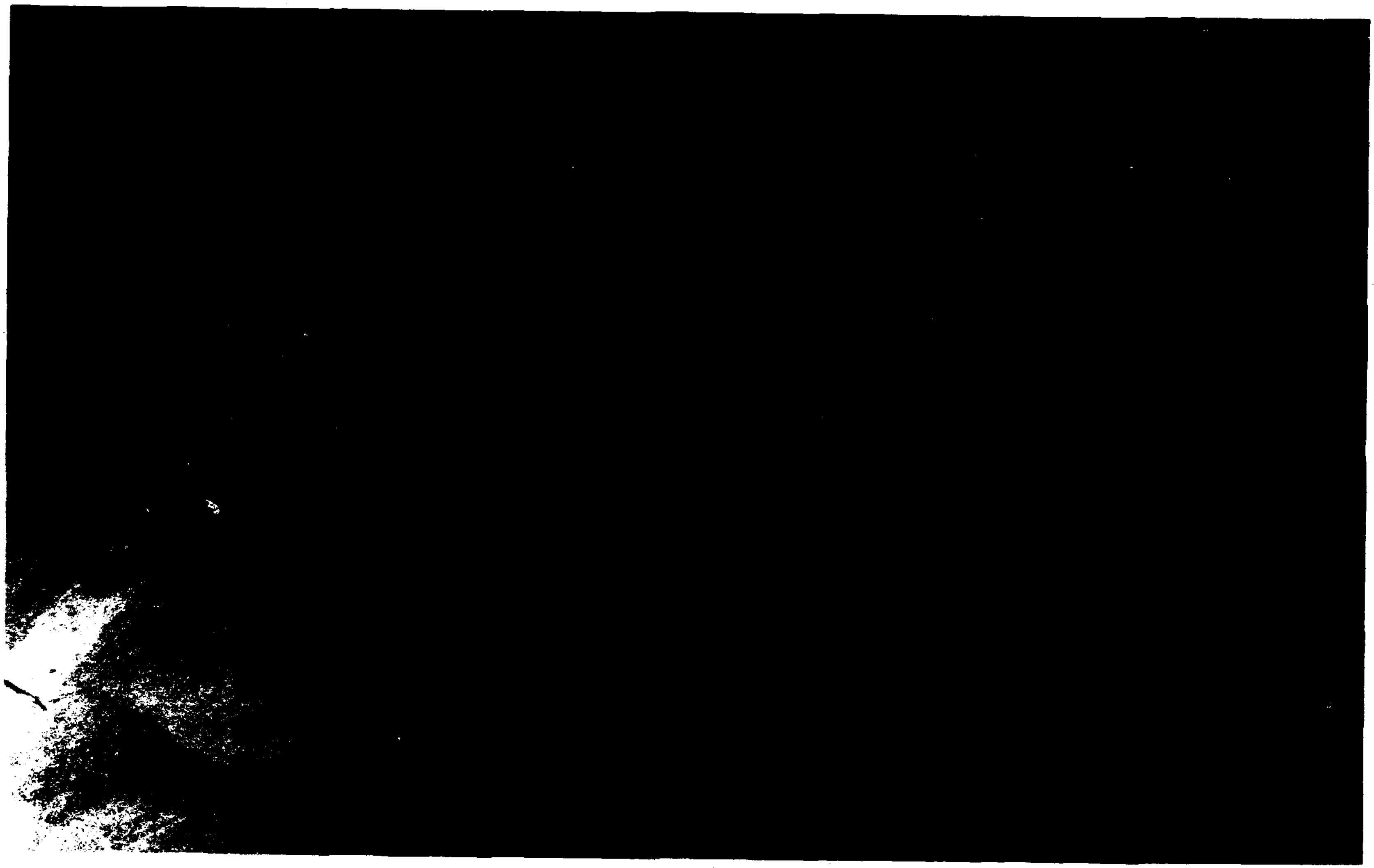

Photo 252. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 5A; swl = +6.7 ft

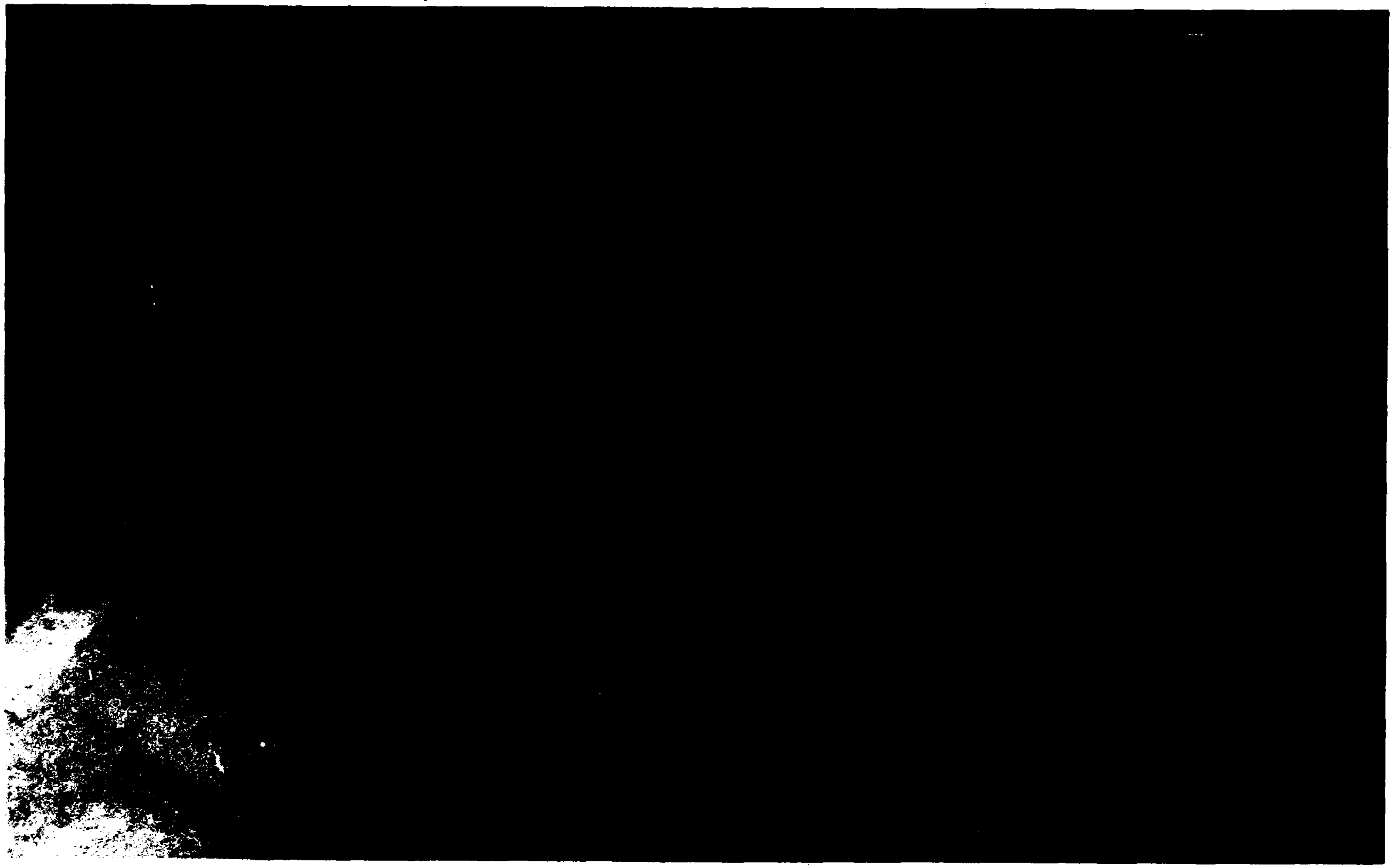

Photo 253. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 5B; swl = +6.7 ft

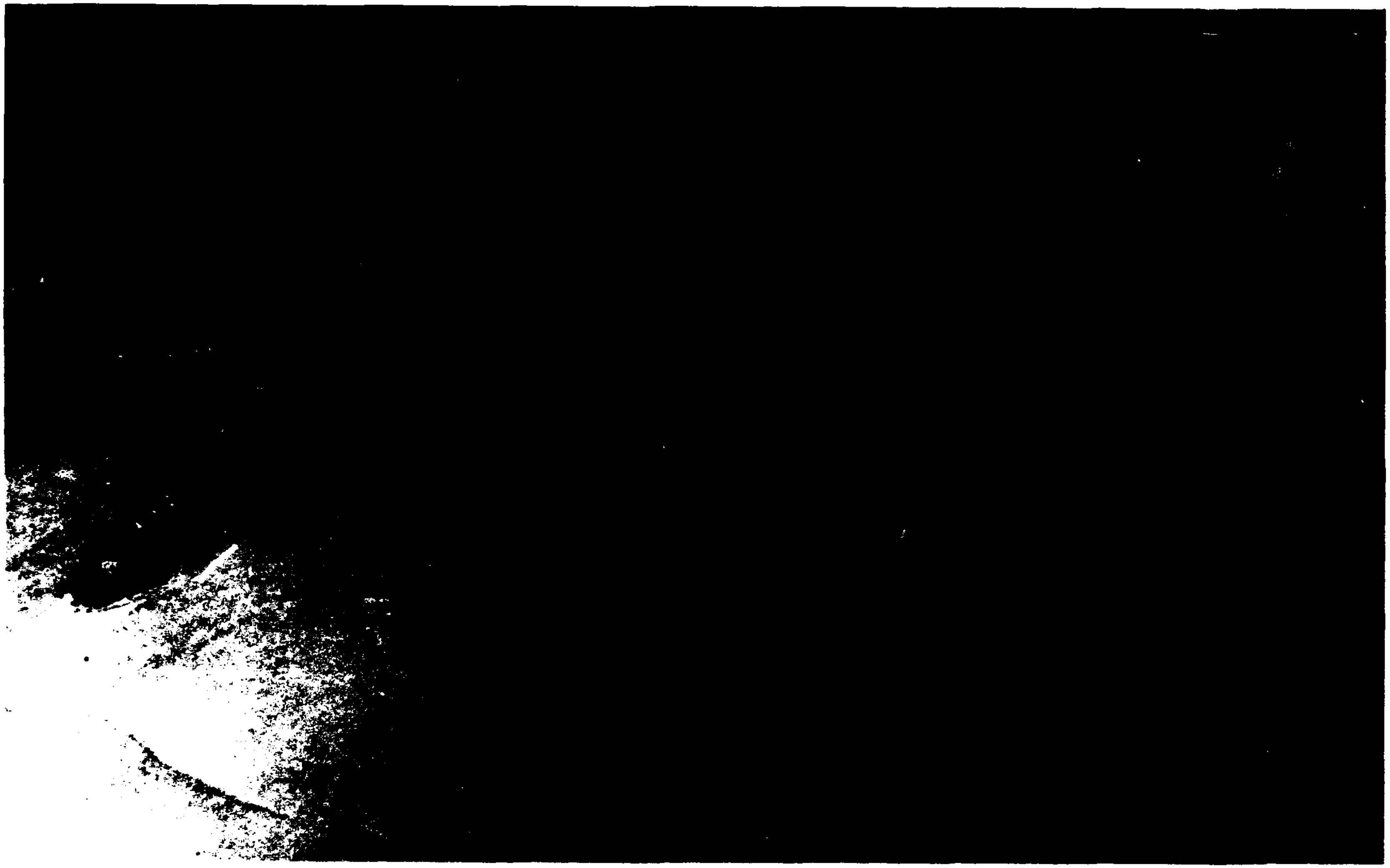

Photo 254. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5B; swl = +6.7 ft

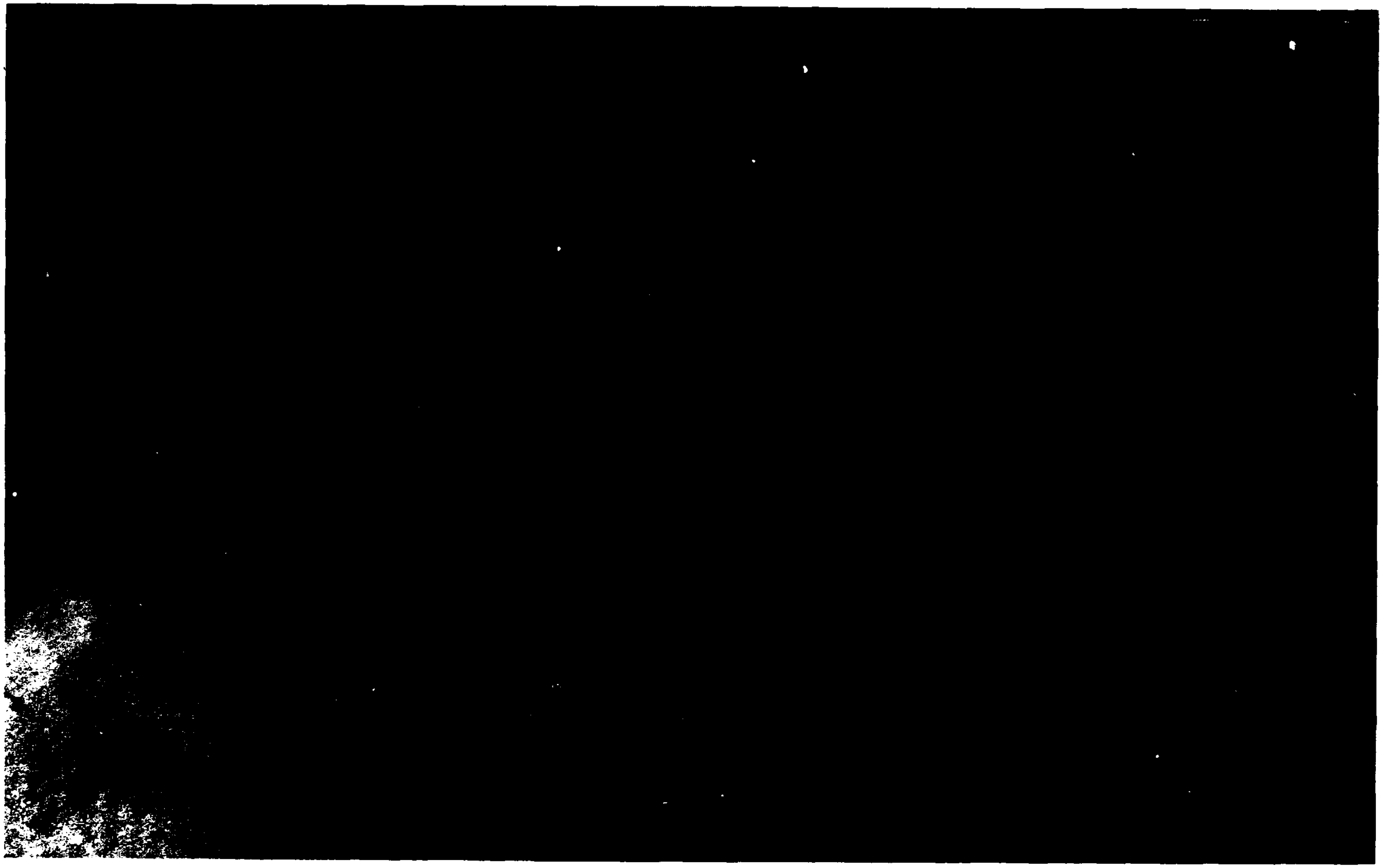

Photo 255. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5C; swl = +6.7 ft

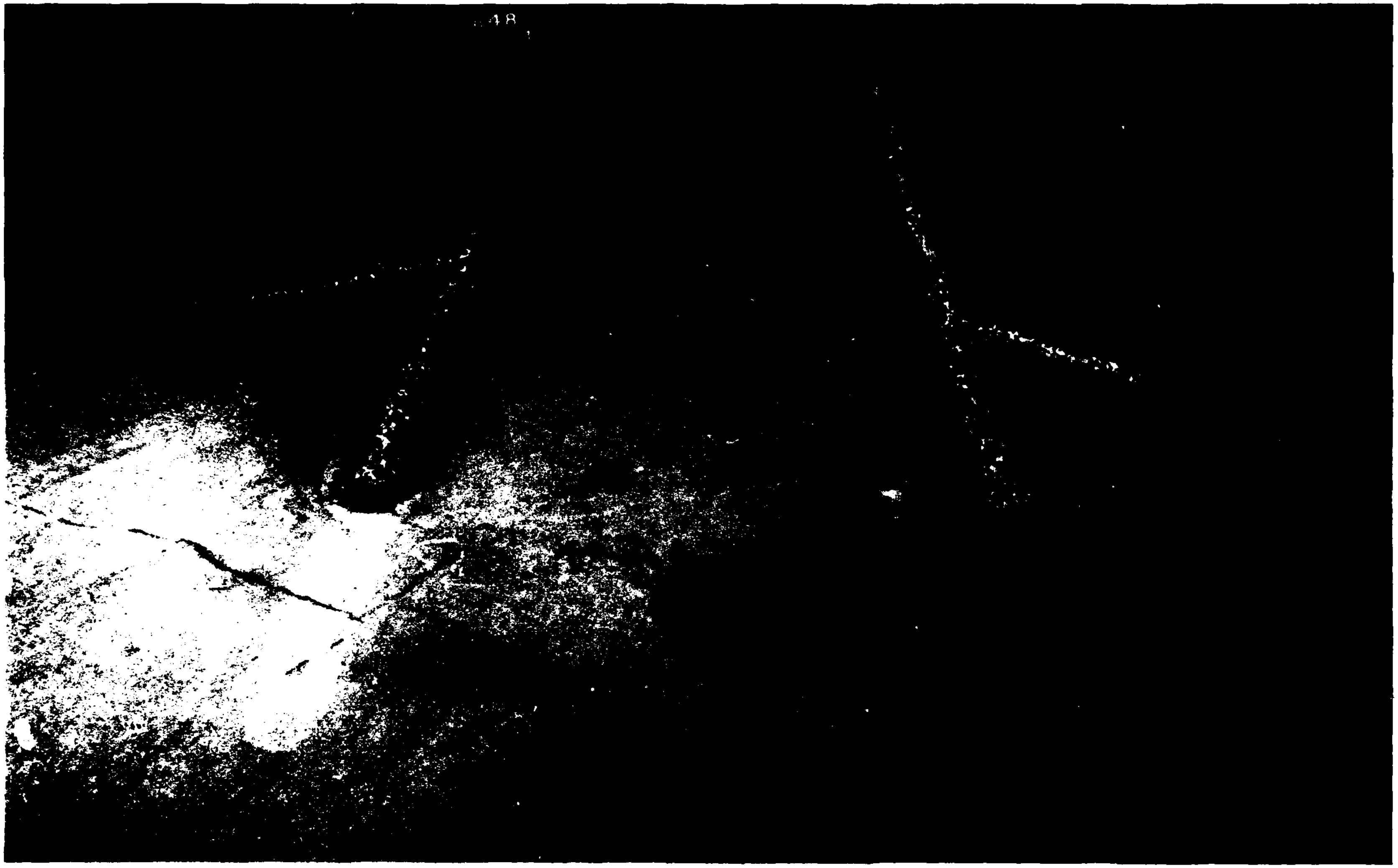

Photo 256. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5D; swl = +6.7 ft

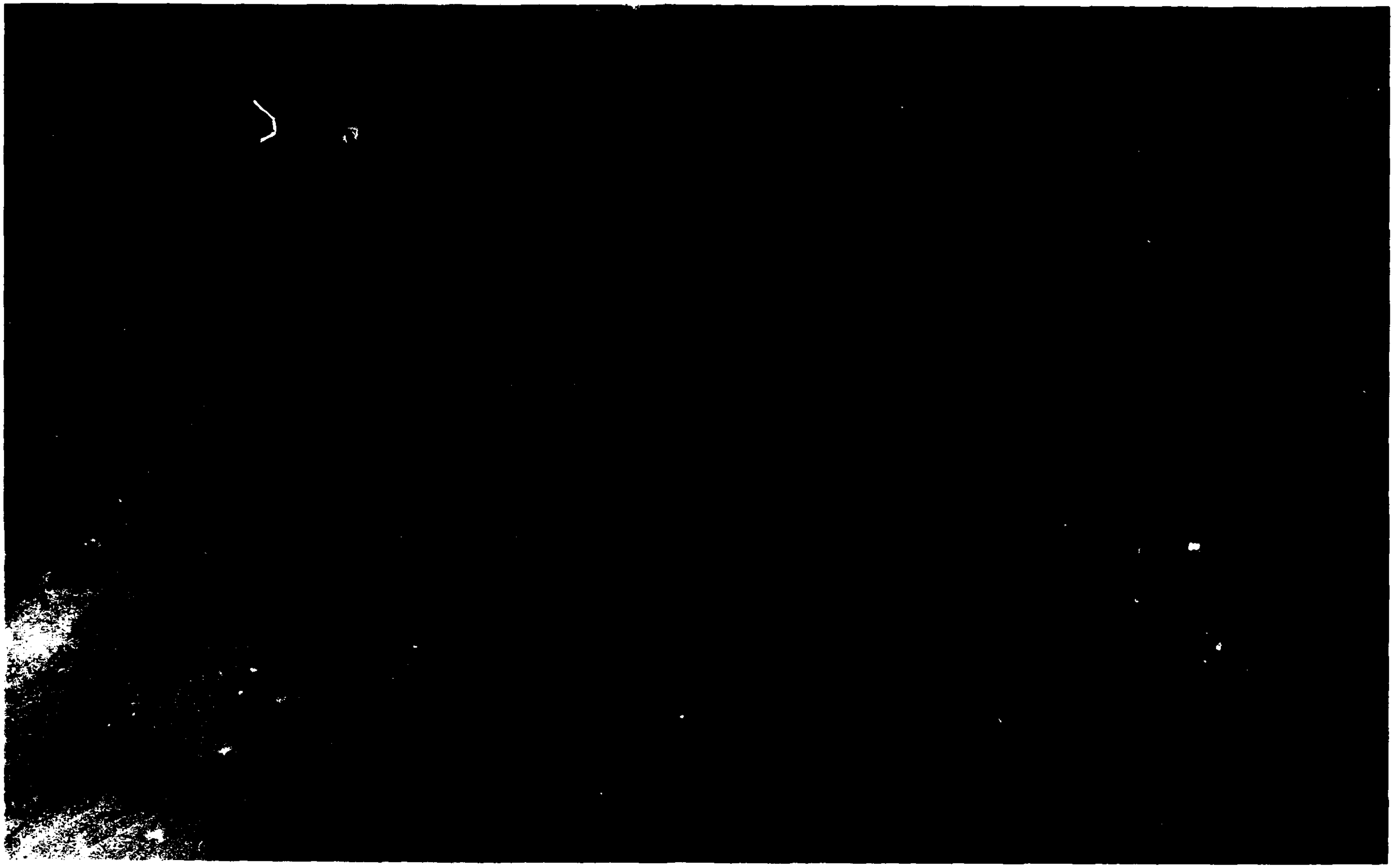

Photo 257. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5E; swl = +6.7 ft

Photo 258. General movement of tracer and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 5E; swl = +6.7 ft

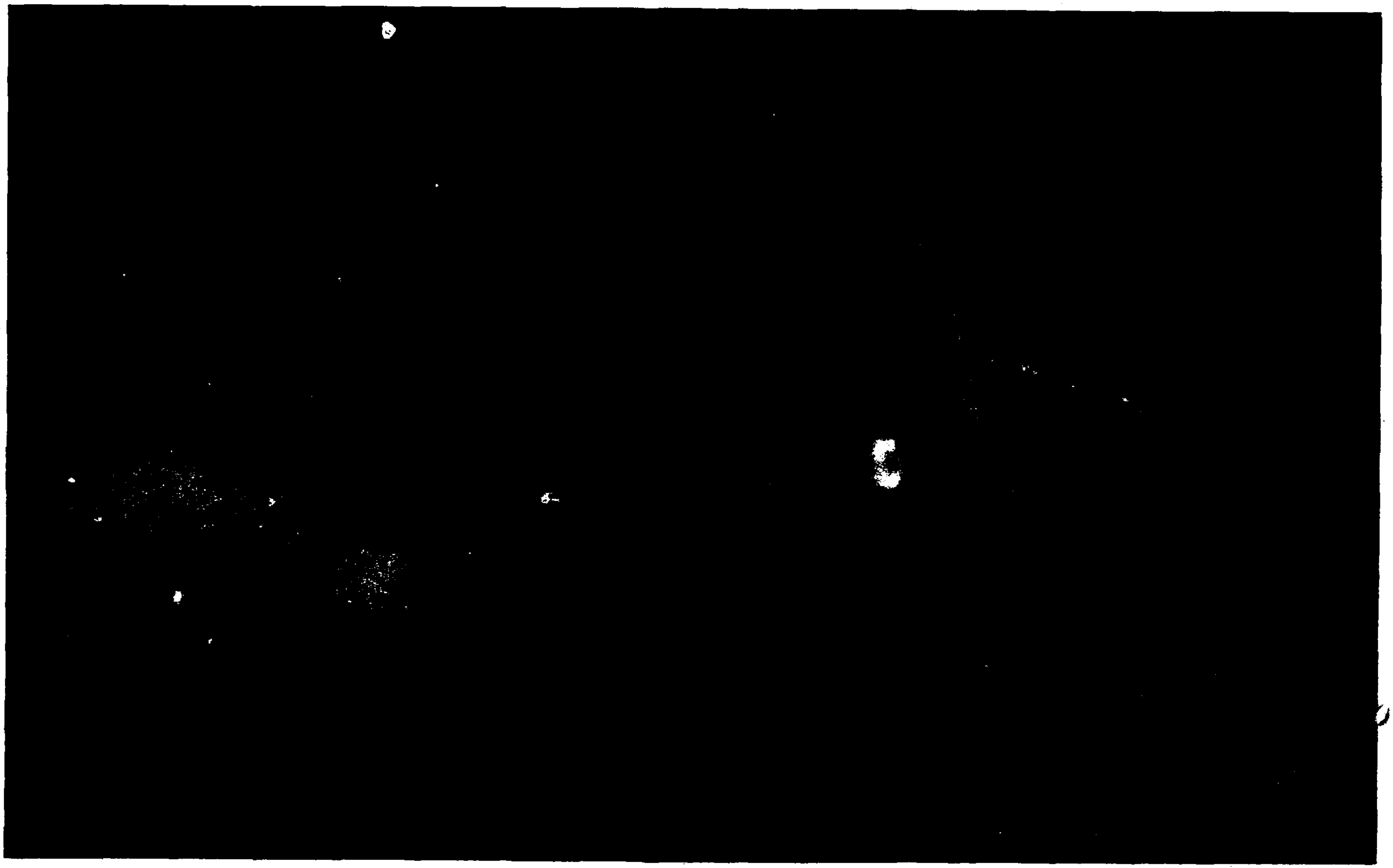

Photo 259. General movement of tracer and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 5E; swl = +6.7 ft

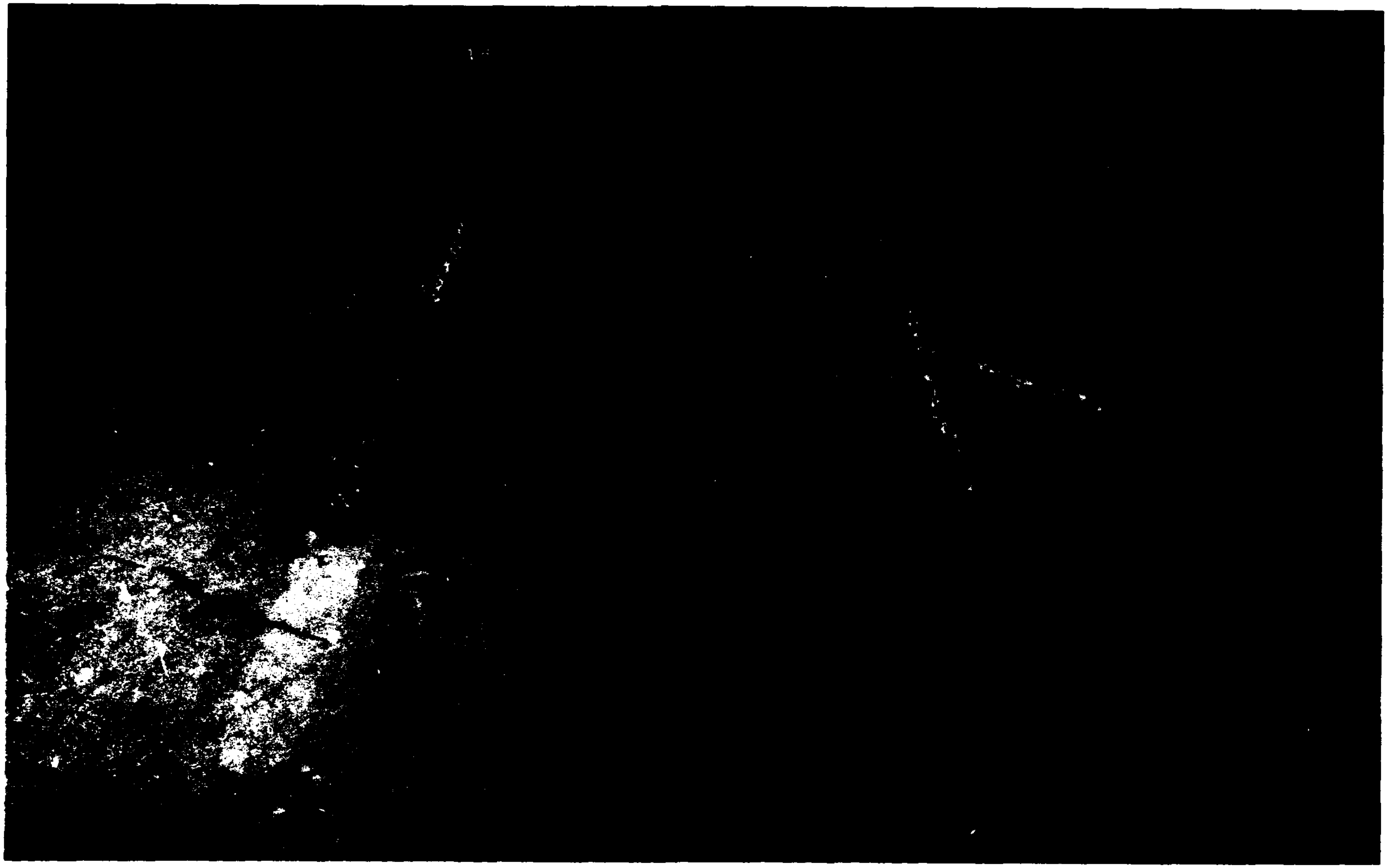

Photo 260. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 5E; swl = +6.7 ft

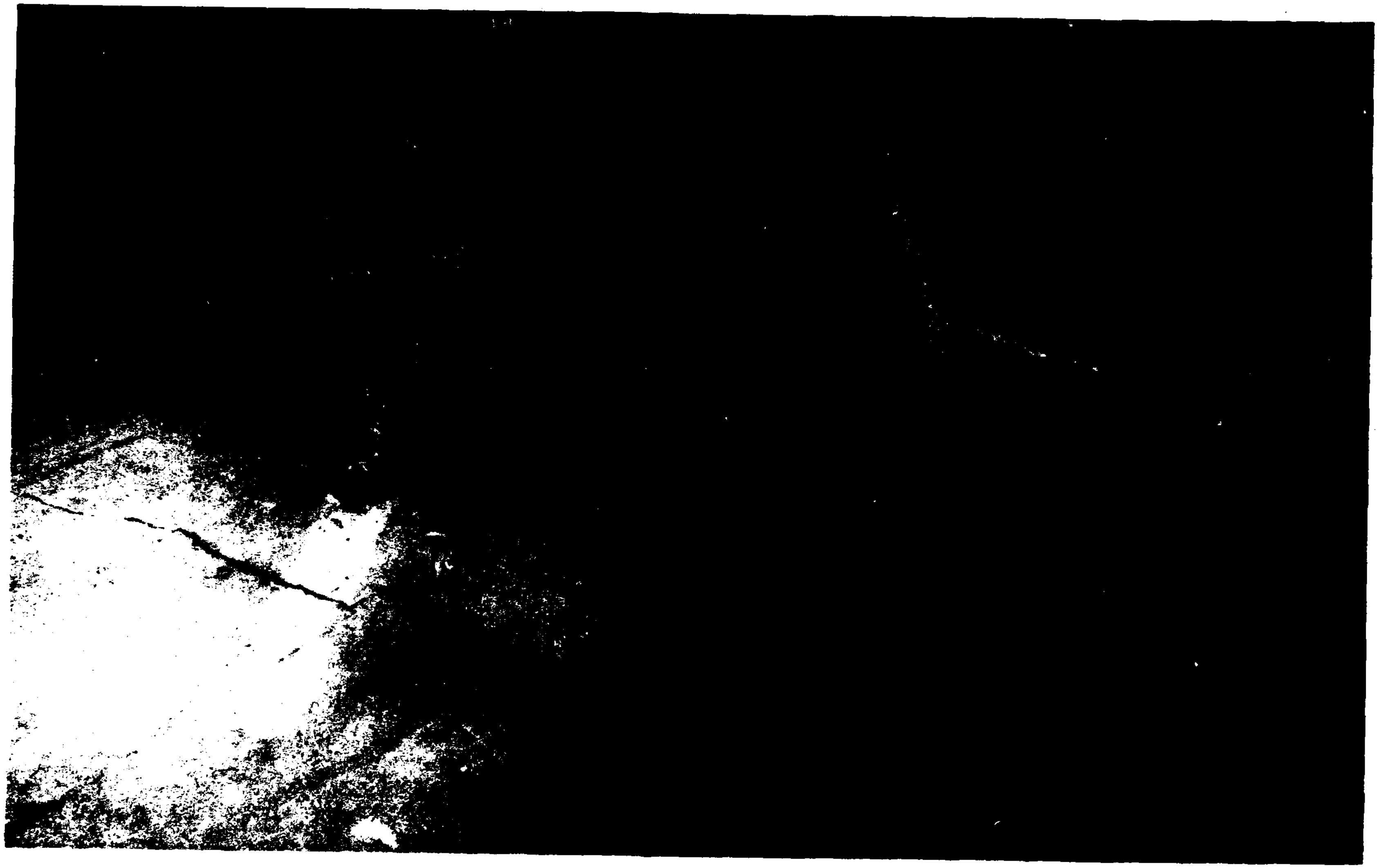

Photo 261. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum flood for Plan 5E; swl = +4.3 ft

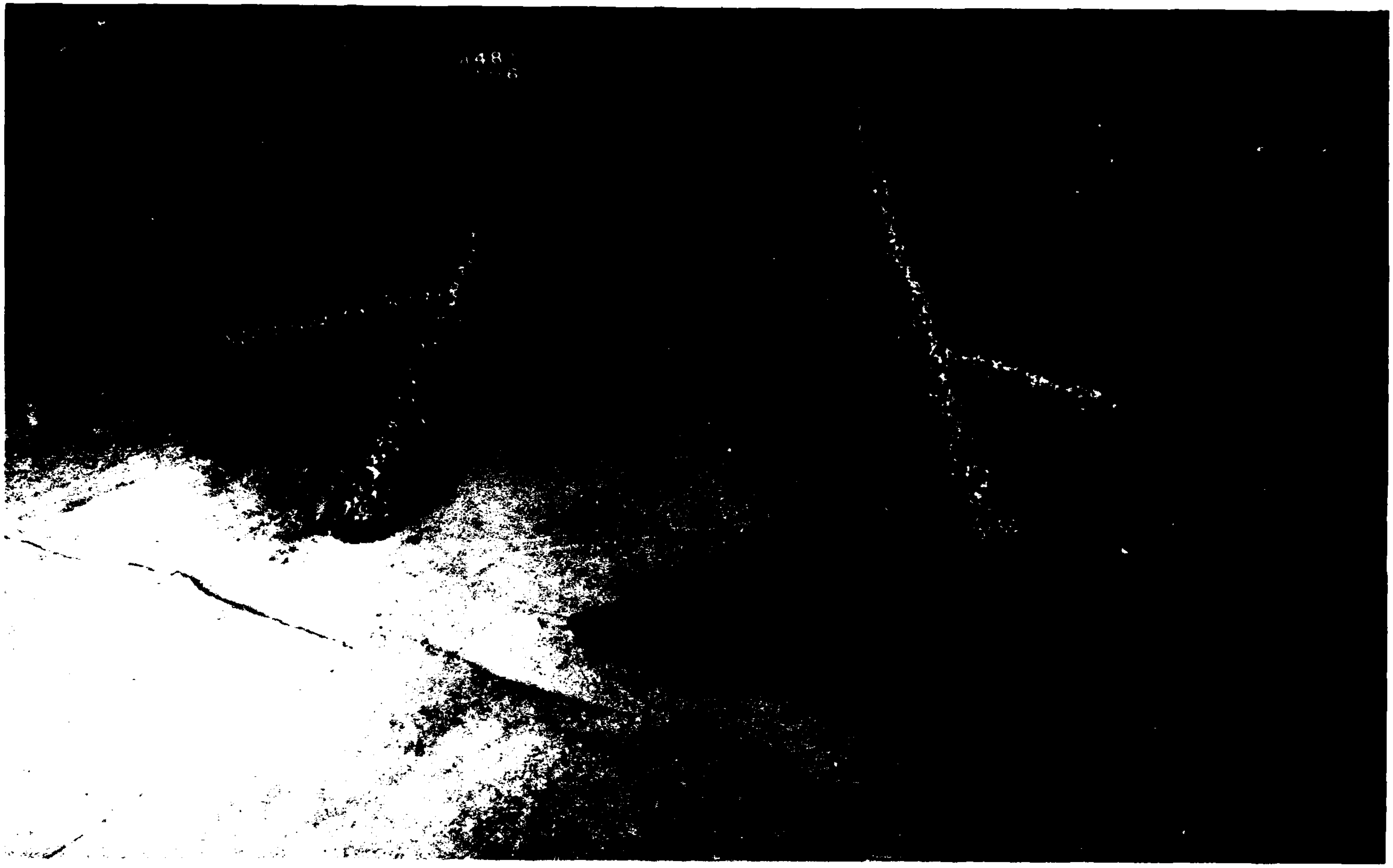

Photo 262. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum ebb for Plan 5E; swl = 1.5 ft

Photo 263. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 5E; swl = 0.0 ft

Photo 264. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for Plan 5E; swl = +6.7 ft

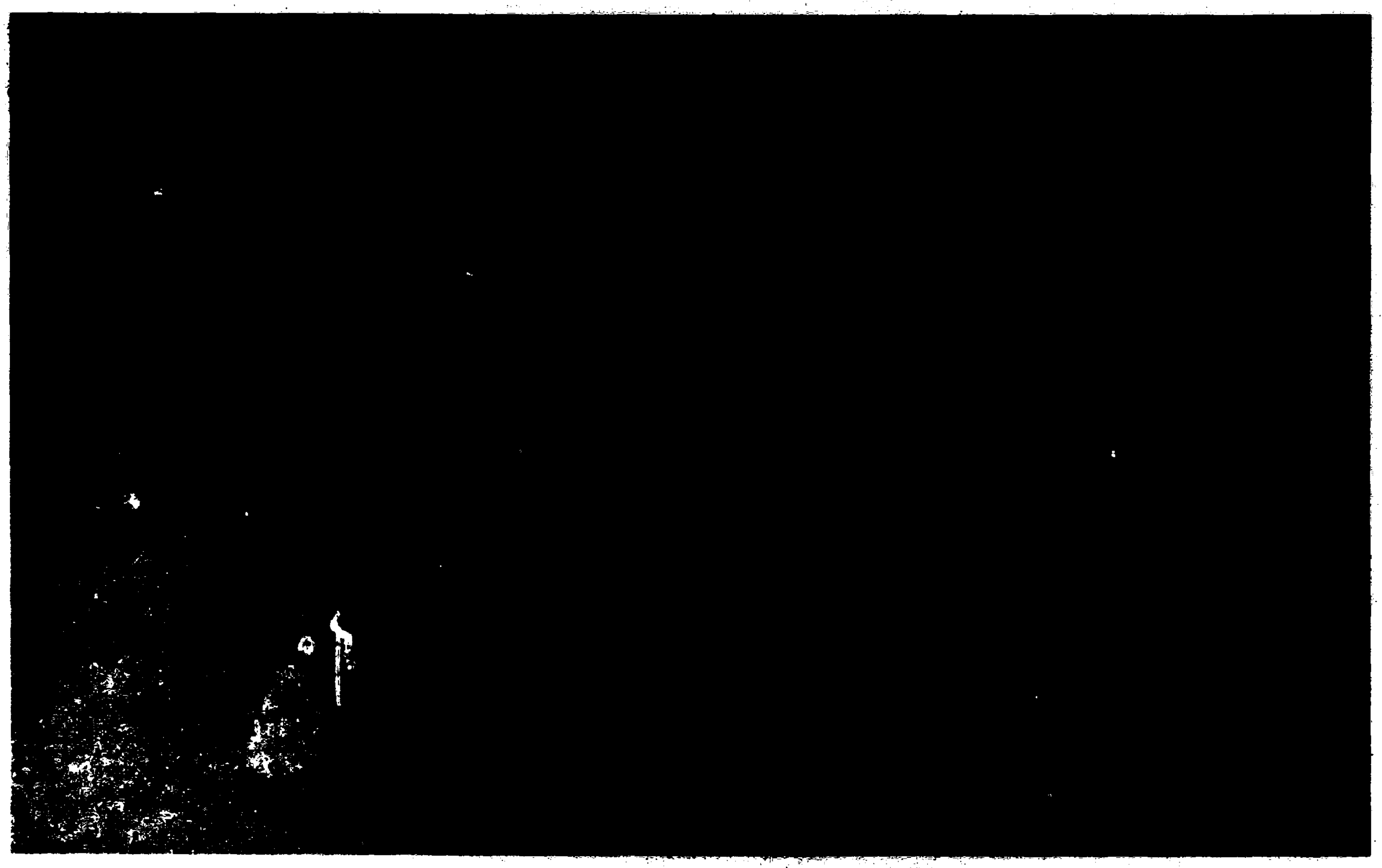

Photo 265. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for Plan 5E; swl = +6.7 ft

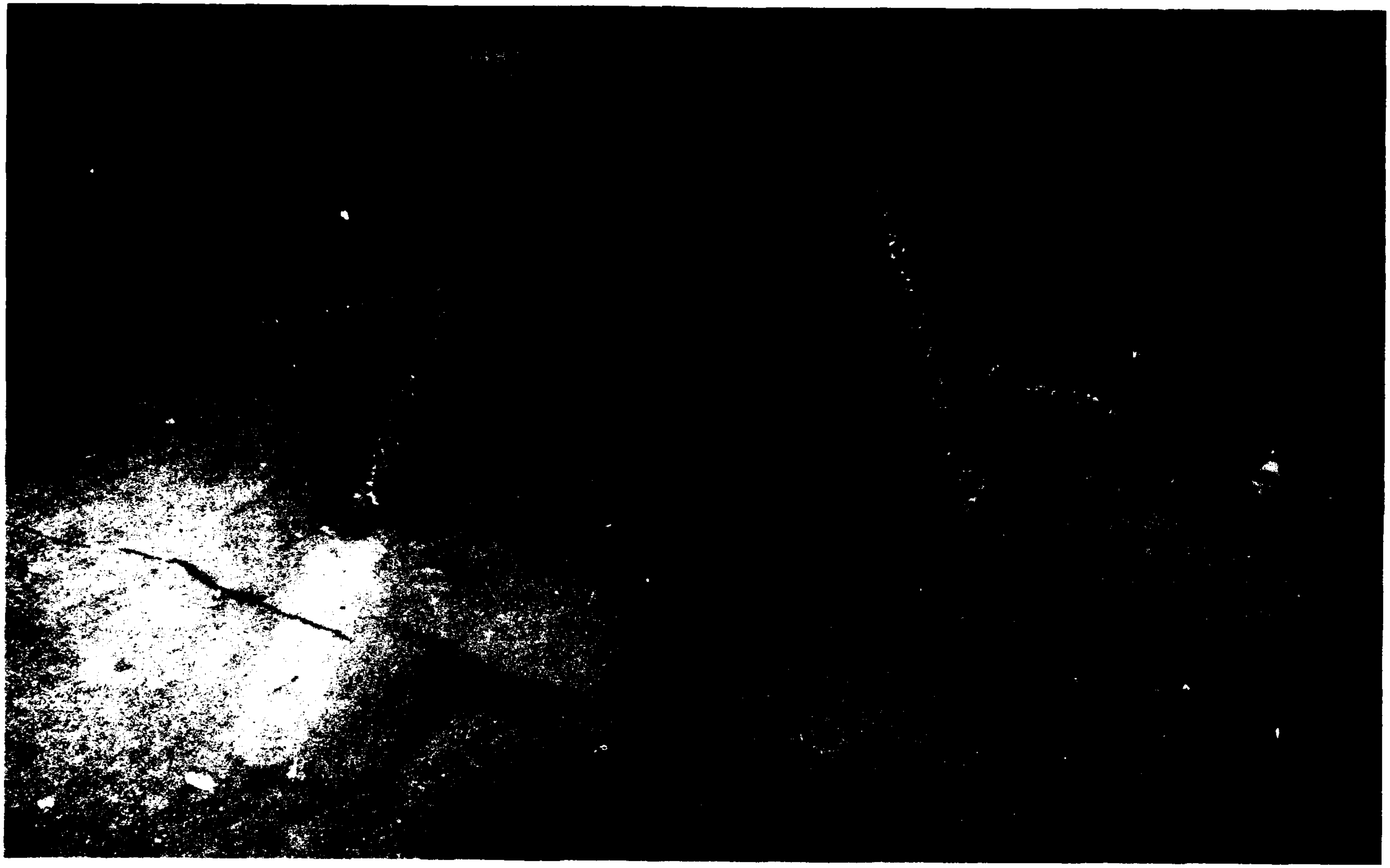

Photo 266. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for Plan 5E; swl = +6.7 ft

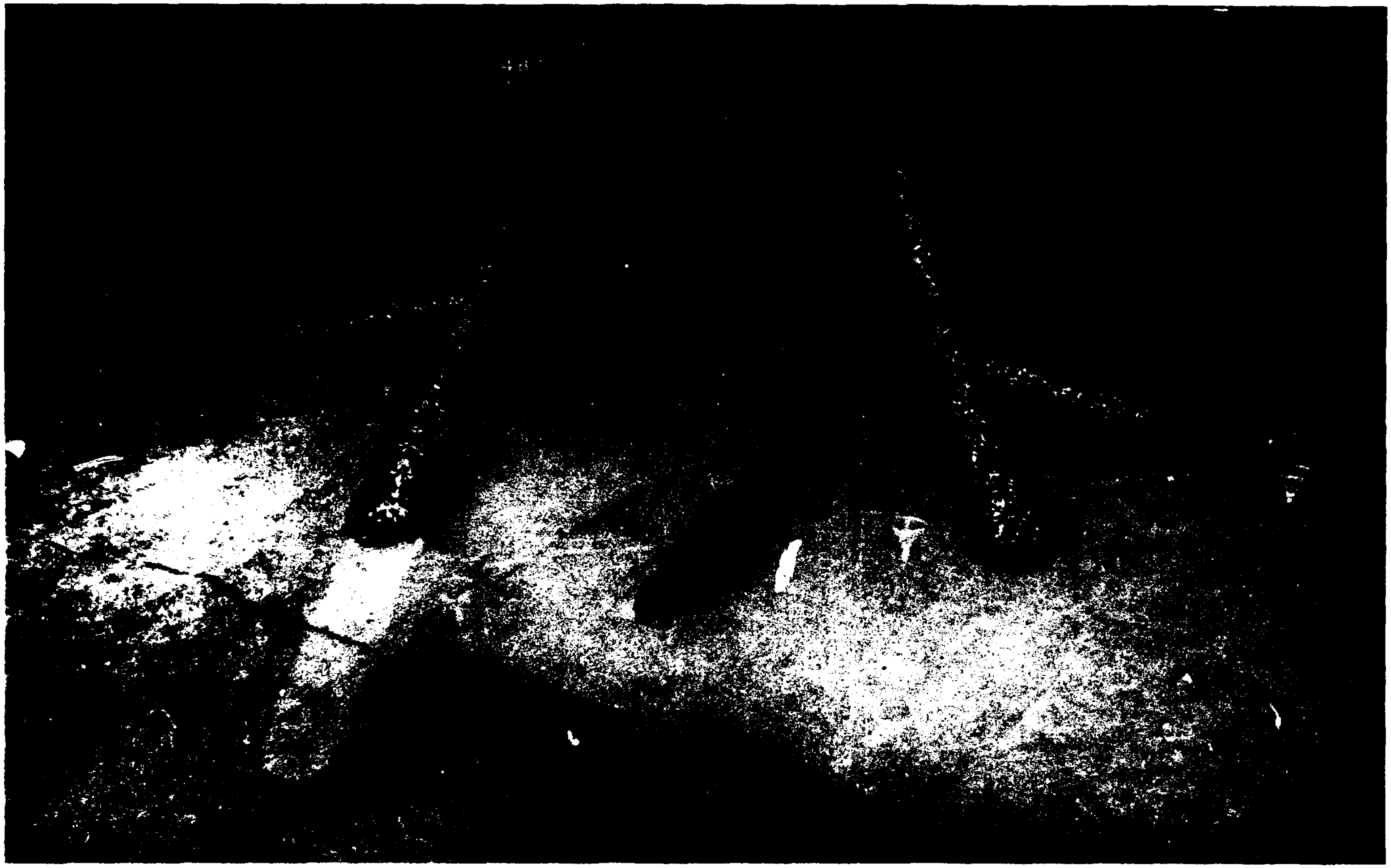

Photo 267. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum flood for Plan 5E; swl = +4.3 ft

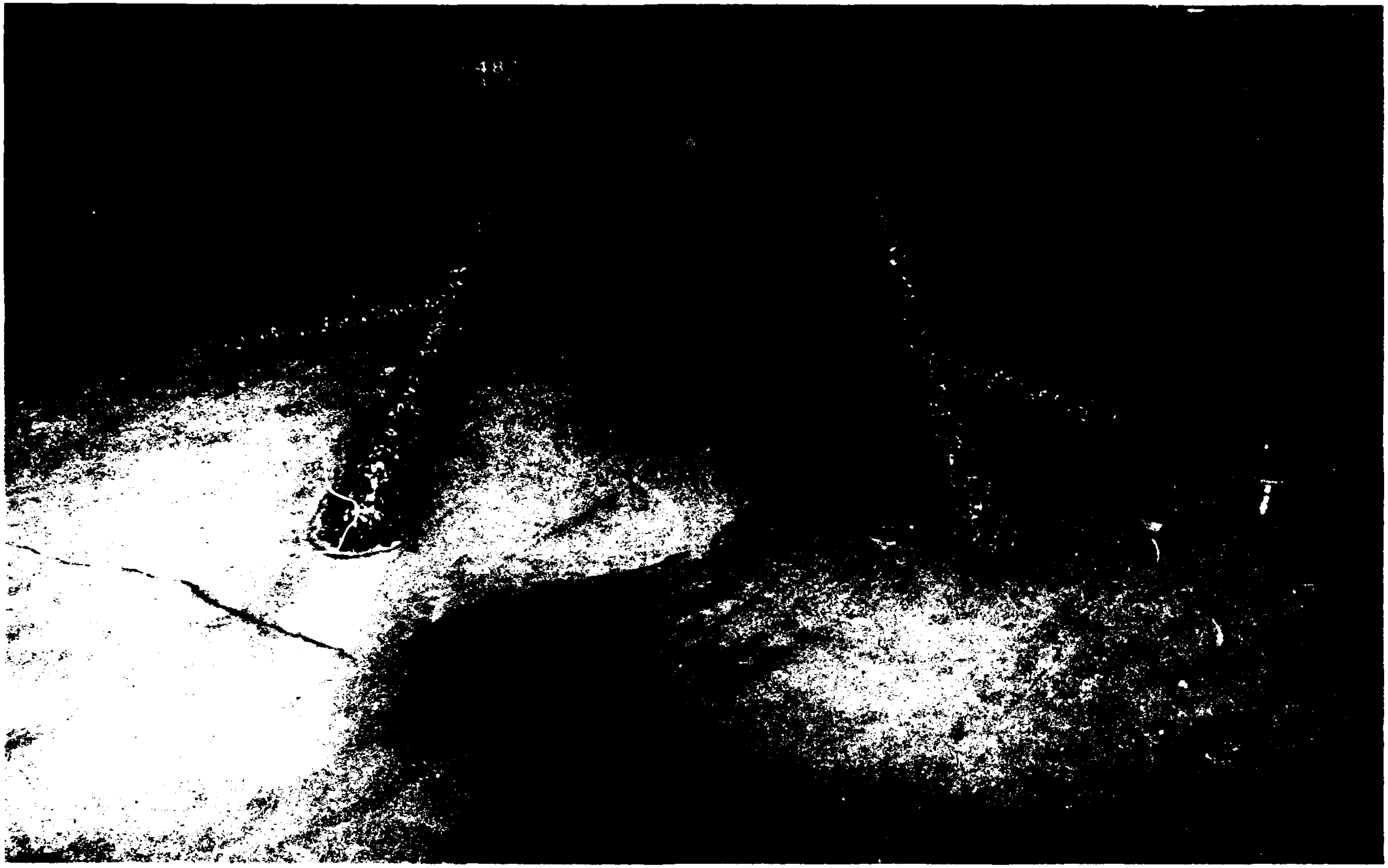

Photo 268. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum ebb for Plan 5E; swl = +1.5 ft

Photo 269. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for Plan 5E, swl = 0.0 ft

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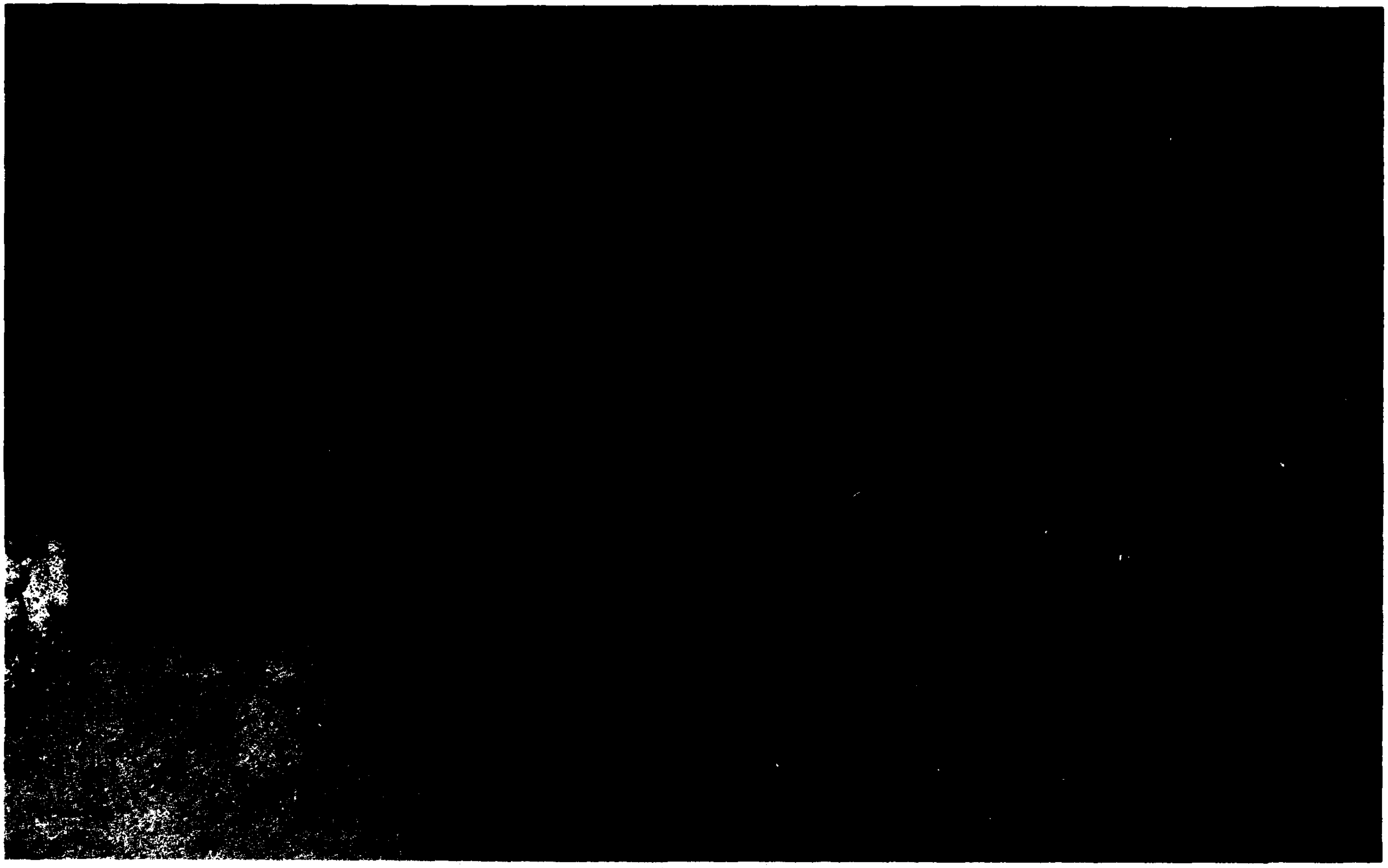


Photo 270. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 5E; swl = +6.7 ft

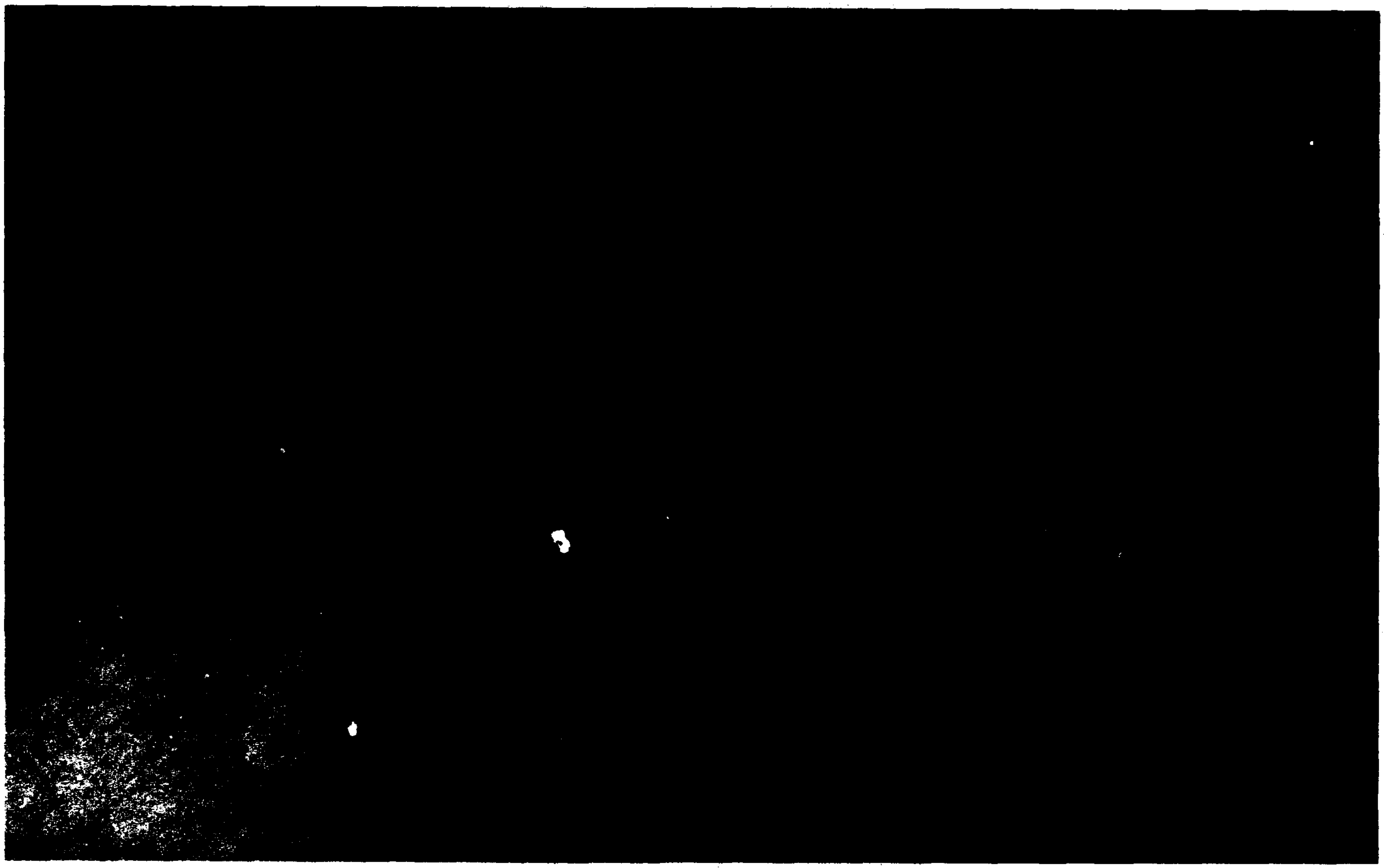


Photo 271. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5E; swl = +6.7 ft

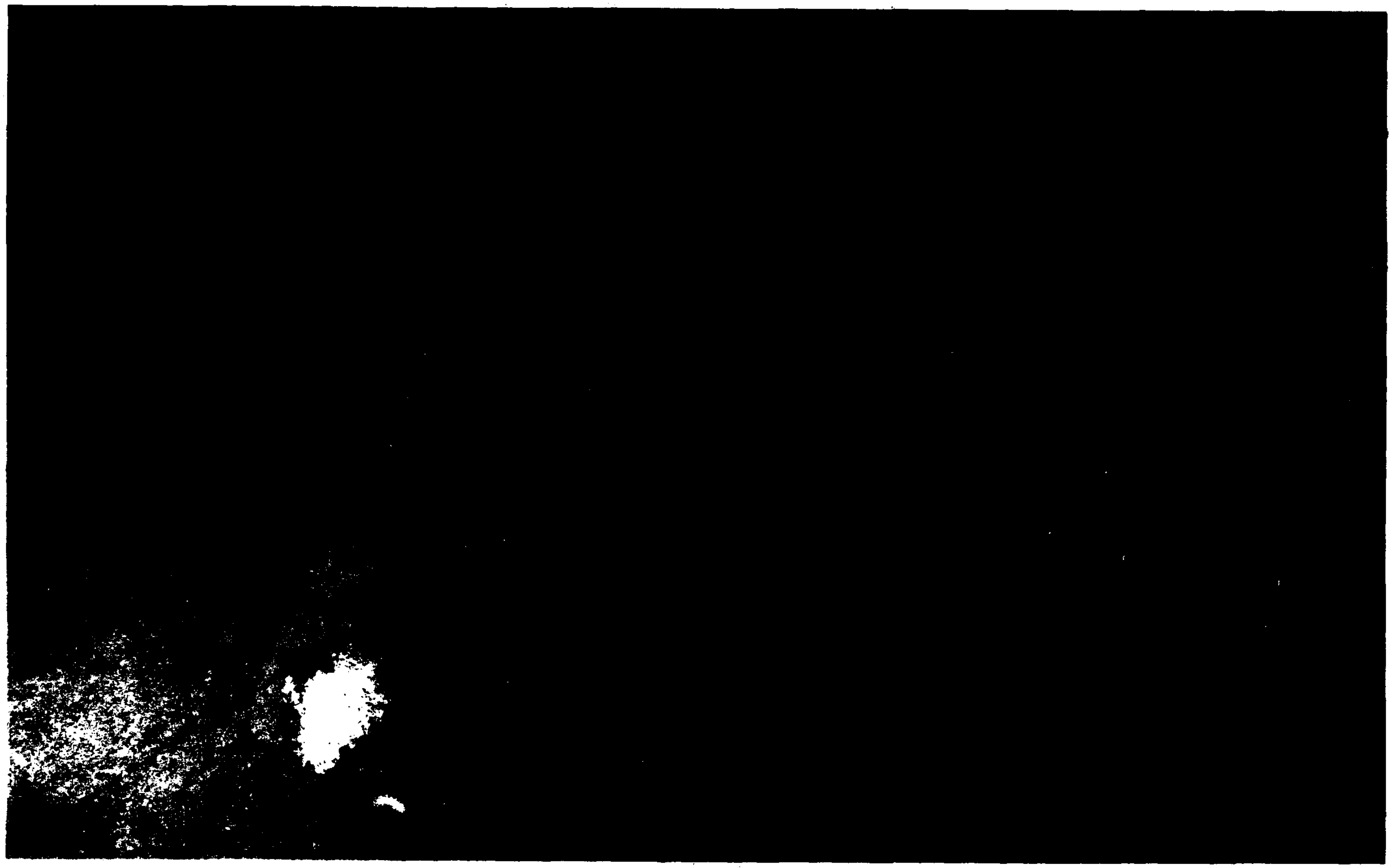


Photo 272. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 5E; swl = +6.7 ft

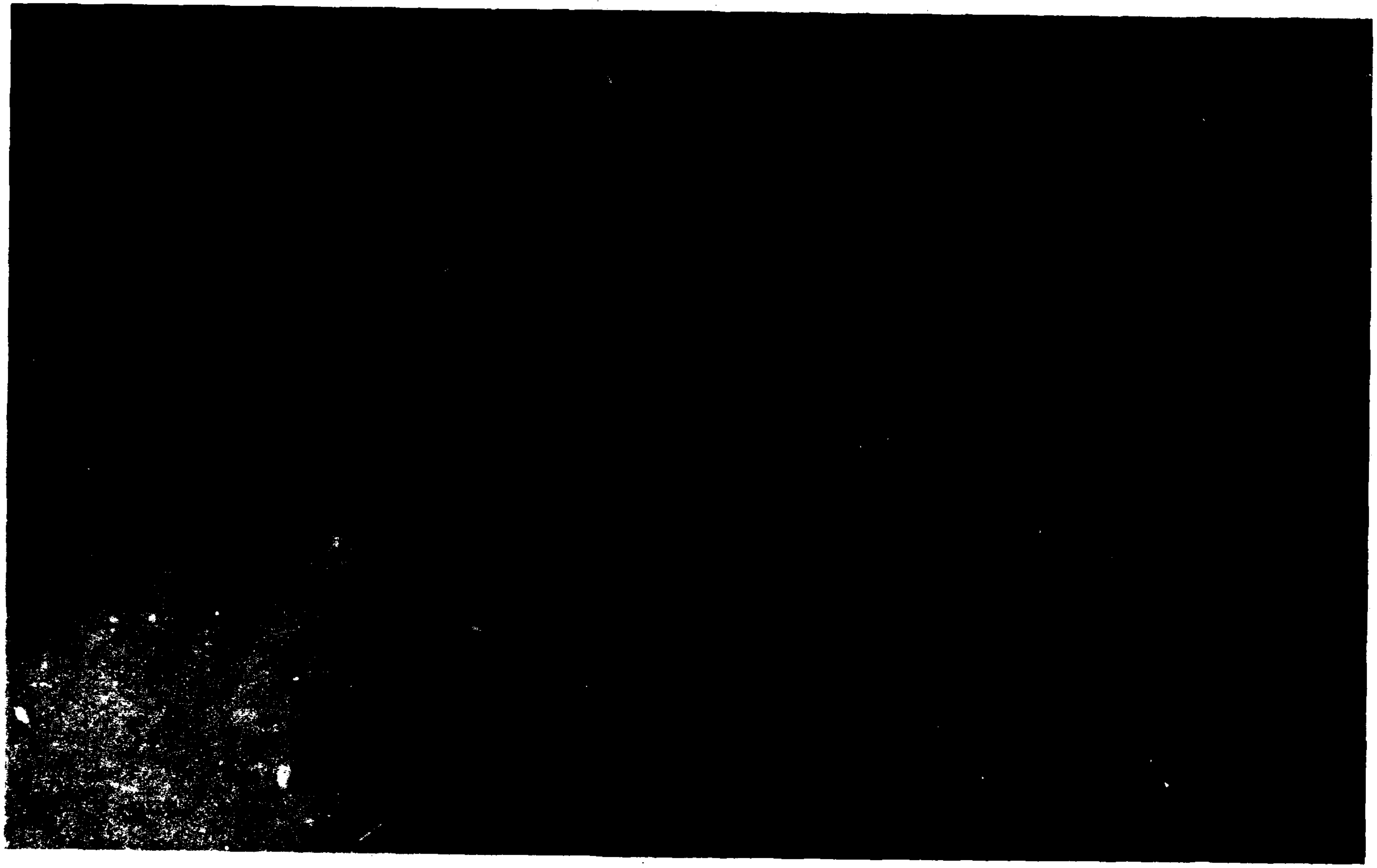


Photo 273. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for maximum flood for Plan 5E; swl = +4.3 ft

Photo 274. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for maximum ebb for Plan 5E; swl = +1.5 ft

Photo 275. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 5E; swl = 0.0 ft

Photo 276. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 5E; swl = 0.0 ft

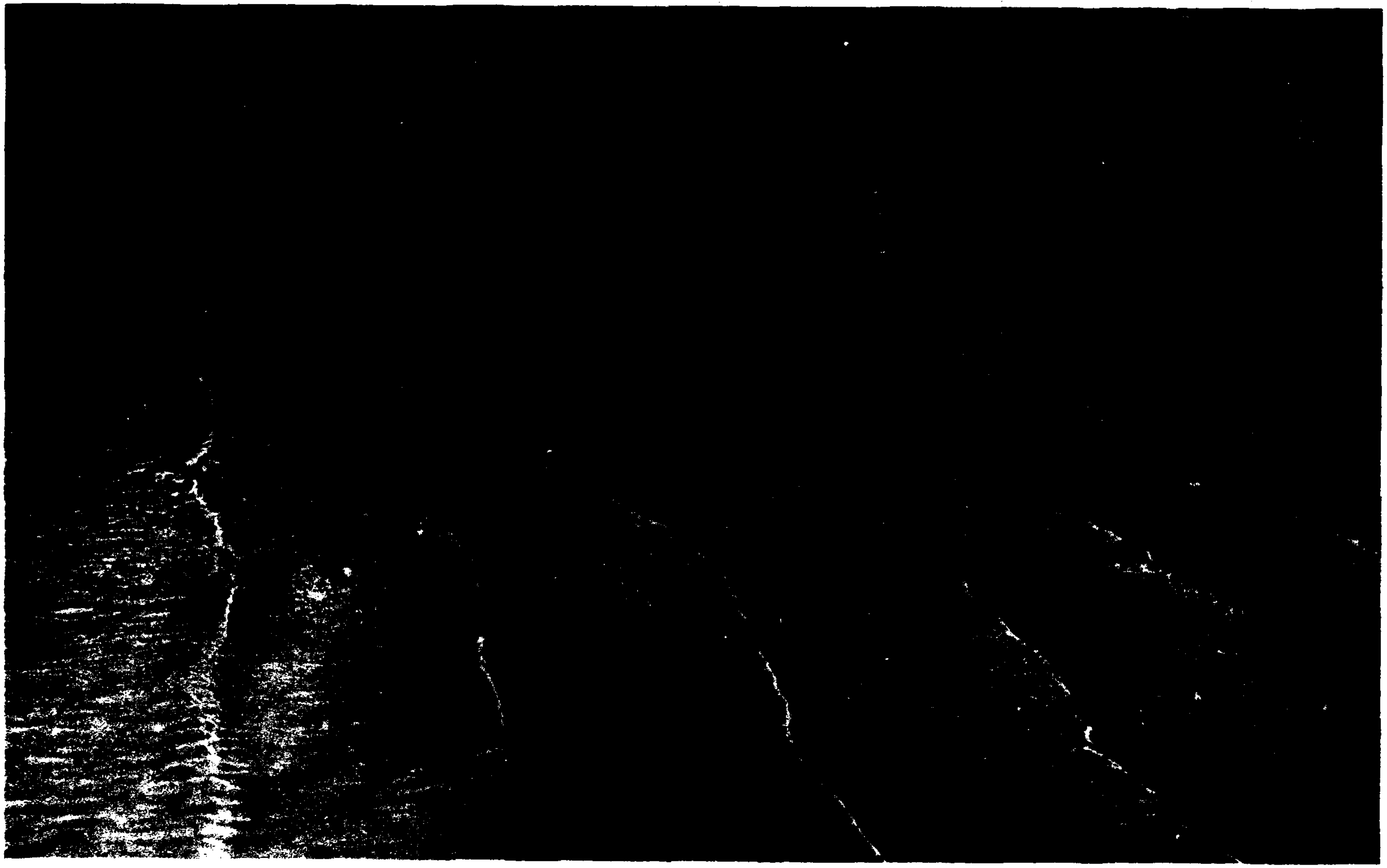


Photo 277. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 5E; 11-sec, 12-ft waves from NNW for maximum ebb; swl = +1.5 ft

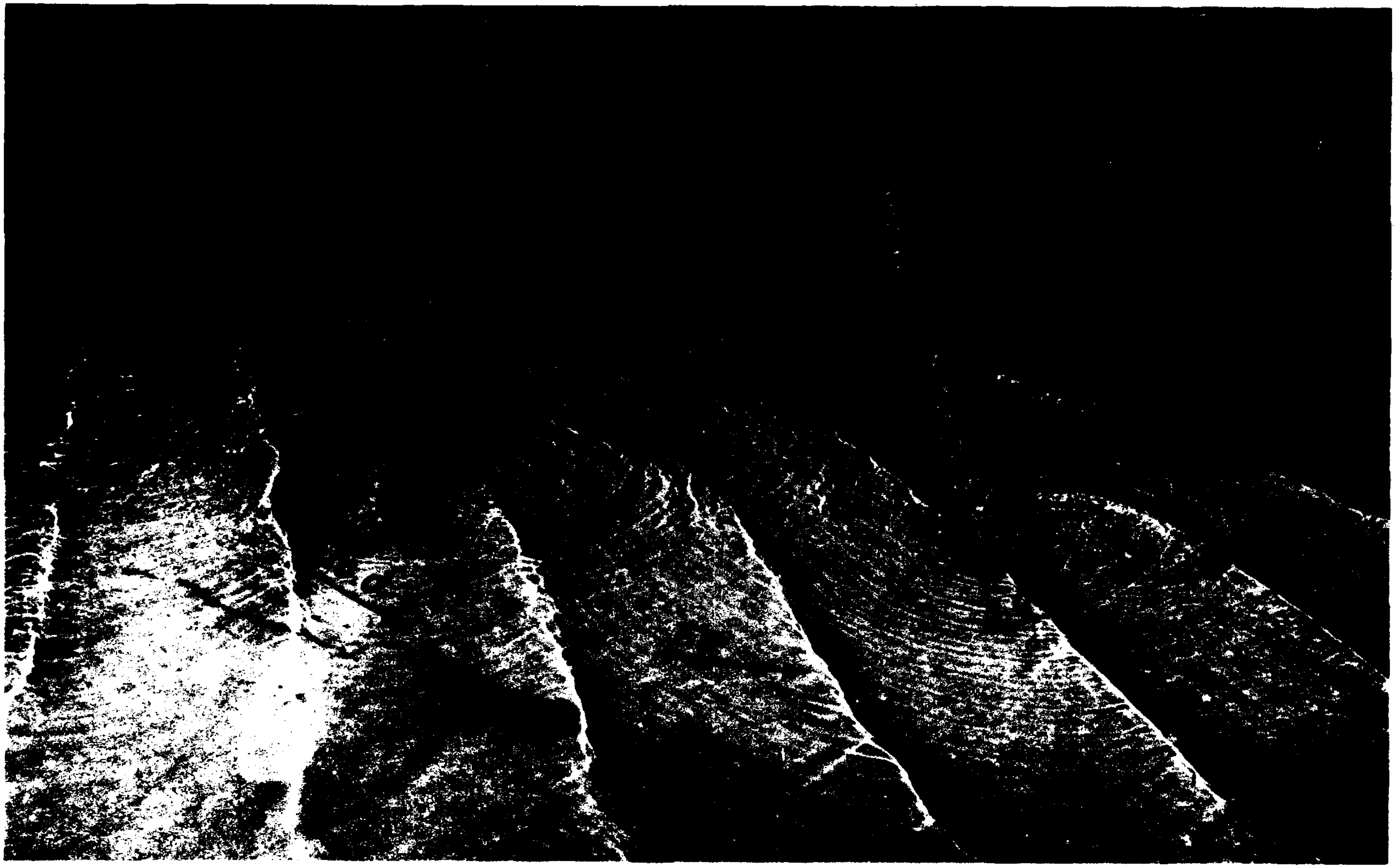


Photo 278. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 5E; 11-sec, 12-ft waves from NNW for maximum flood; swl = +4.3 ft

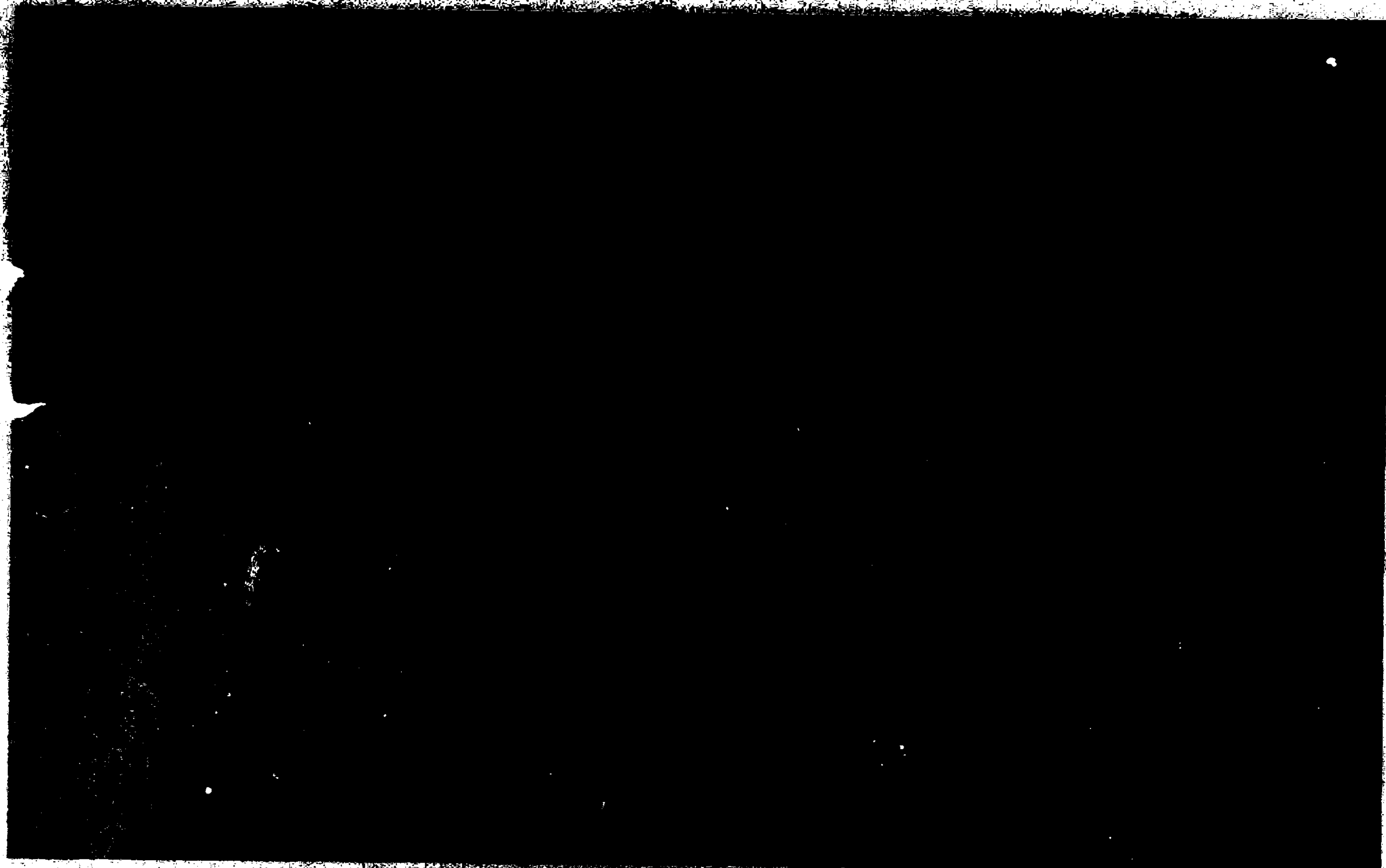


Photo 279. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 3B, 11-sec, 12-ft waves from NNW; swl = +6.7 ft

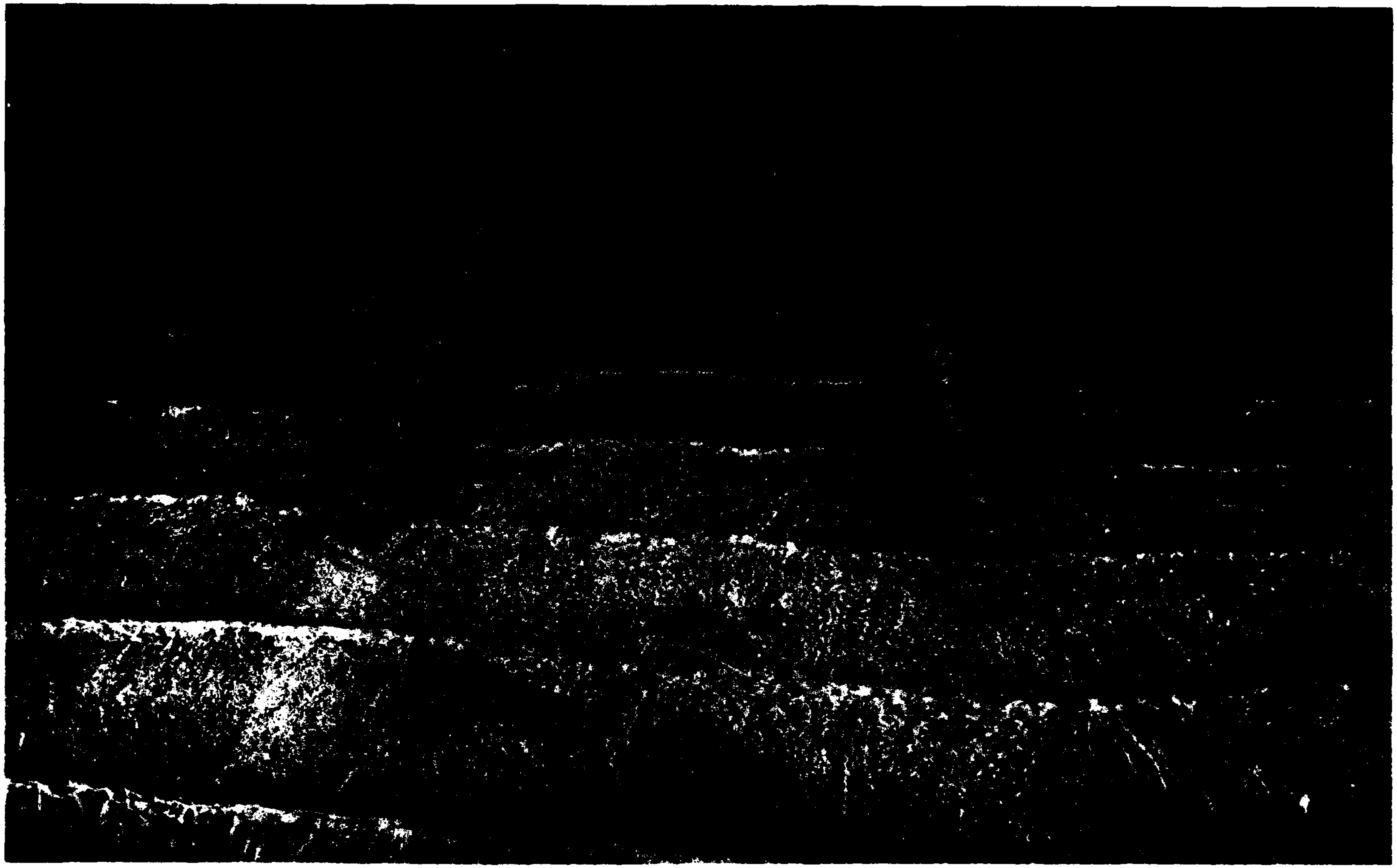


Photo 280. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 5E; 11-sec, 12-ft waves from SSW for maximum ebb; swl = +1.5 ft

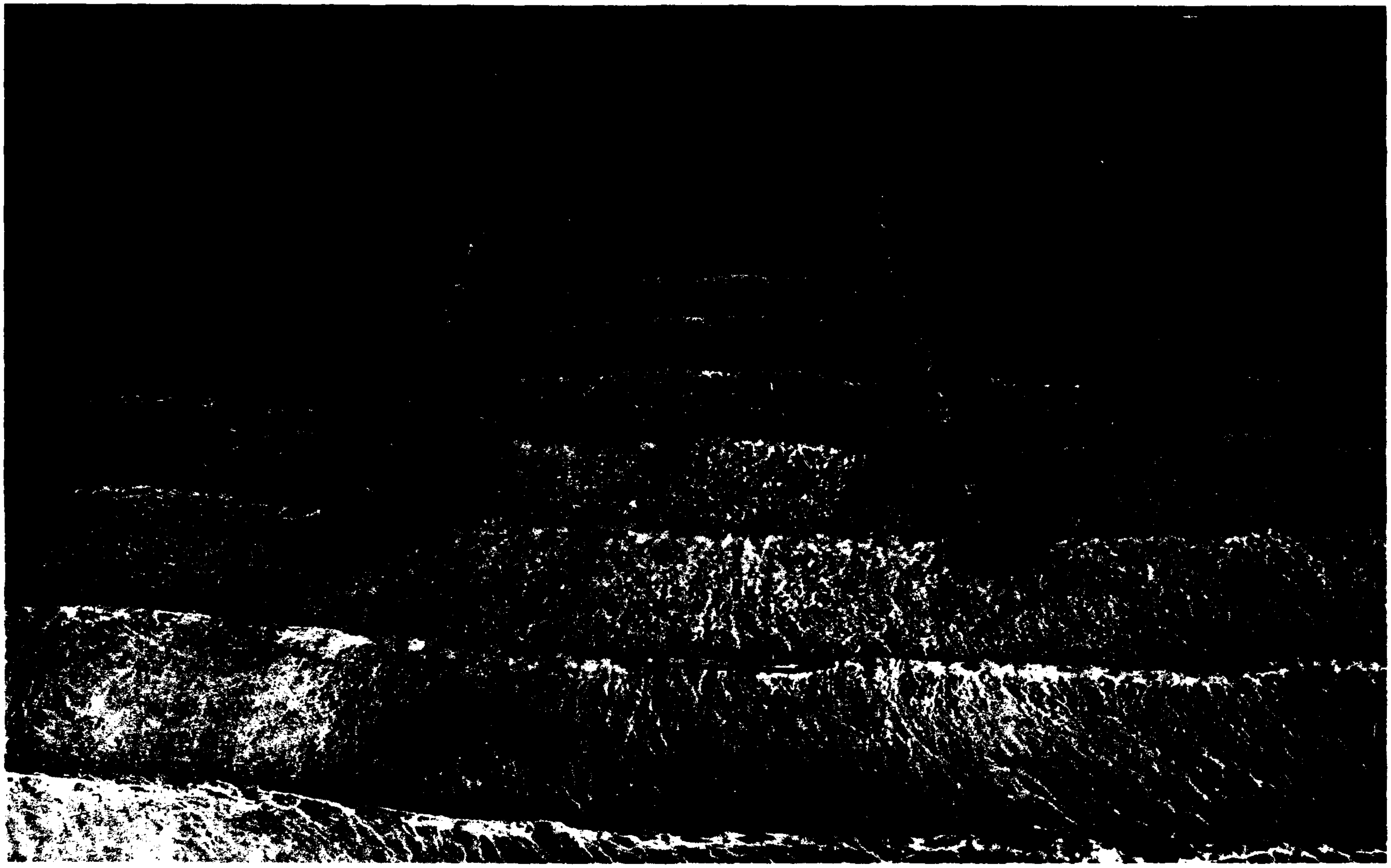


Photo 281. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 5E; 11-sec, 12-ft waves from SSW for maximum flood; swl = +4.3 ft

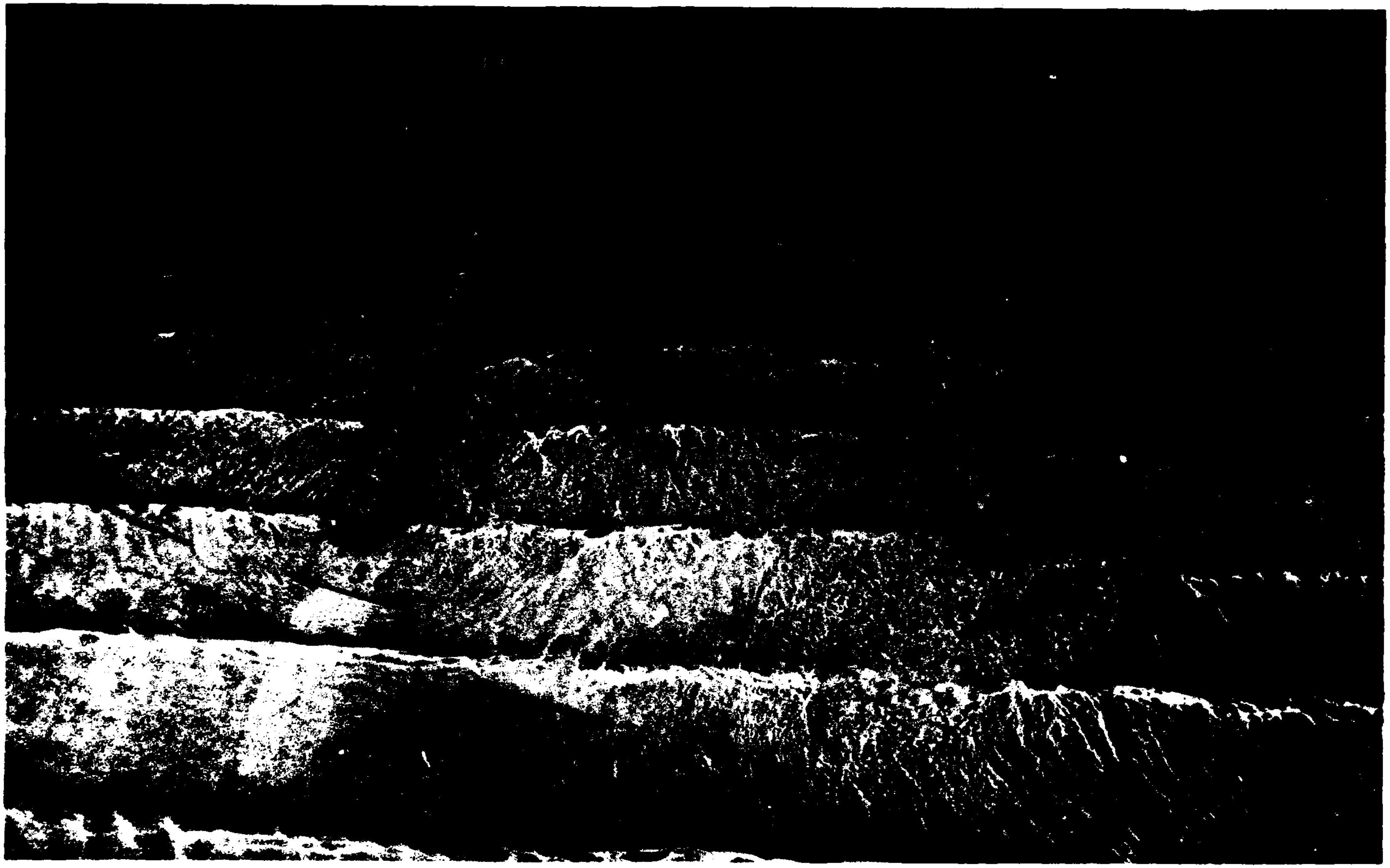


Photo 282. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for Plan 5E; 11-sec, 12-ft waves from SSW; swl = +6.7 ft

Photo 283. Shoal formed for Plan 5E; 13-sec, 27-ft waves from SW

Photo 284. Closer view of shoal formed by 13-sec, 27-ft waves from SW for Plan 5E

Photo 285. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 6; swl = +6.7 ft

Photo 286. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 6A; swl = +6.7 ft

Photo 287. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 6B; swl = +6.7 ft

Photo 288. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 6C; swl = +6.7 ft

Photo 289. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 6D; swl = +6.7 ft

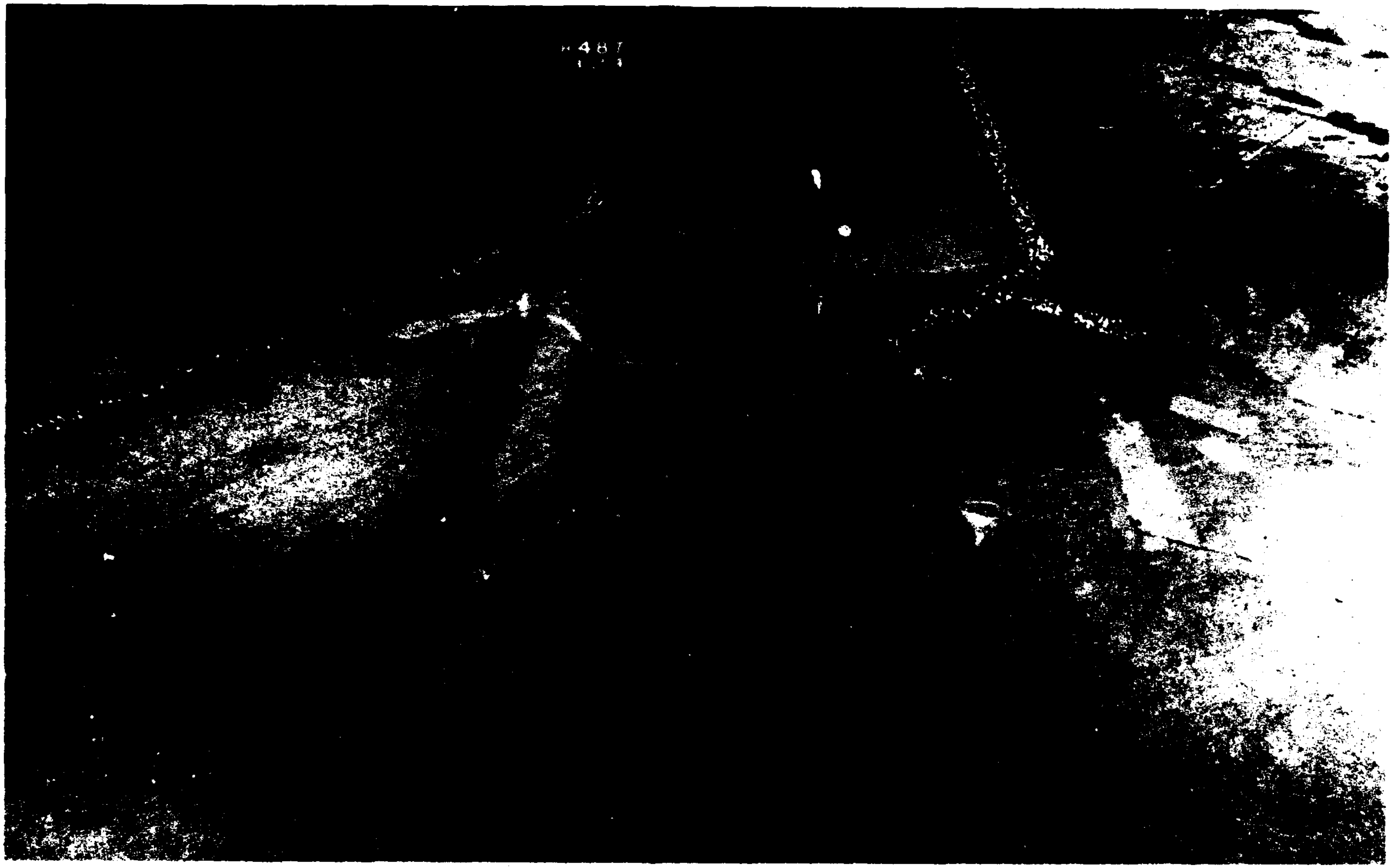


Photo 290. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 6D; swl = +6.7 ft

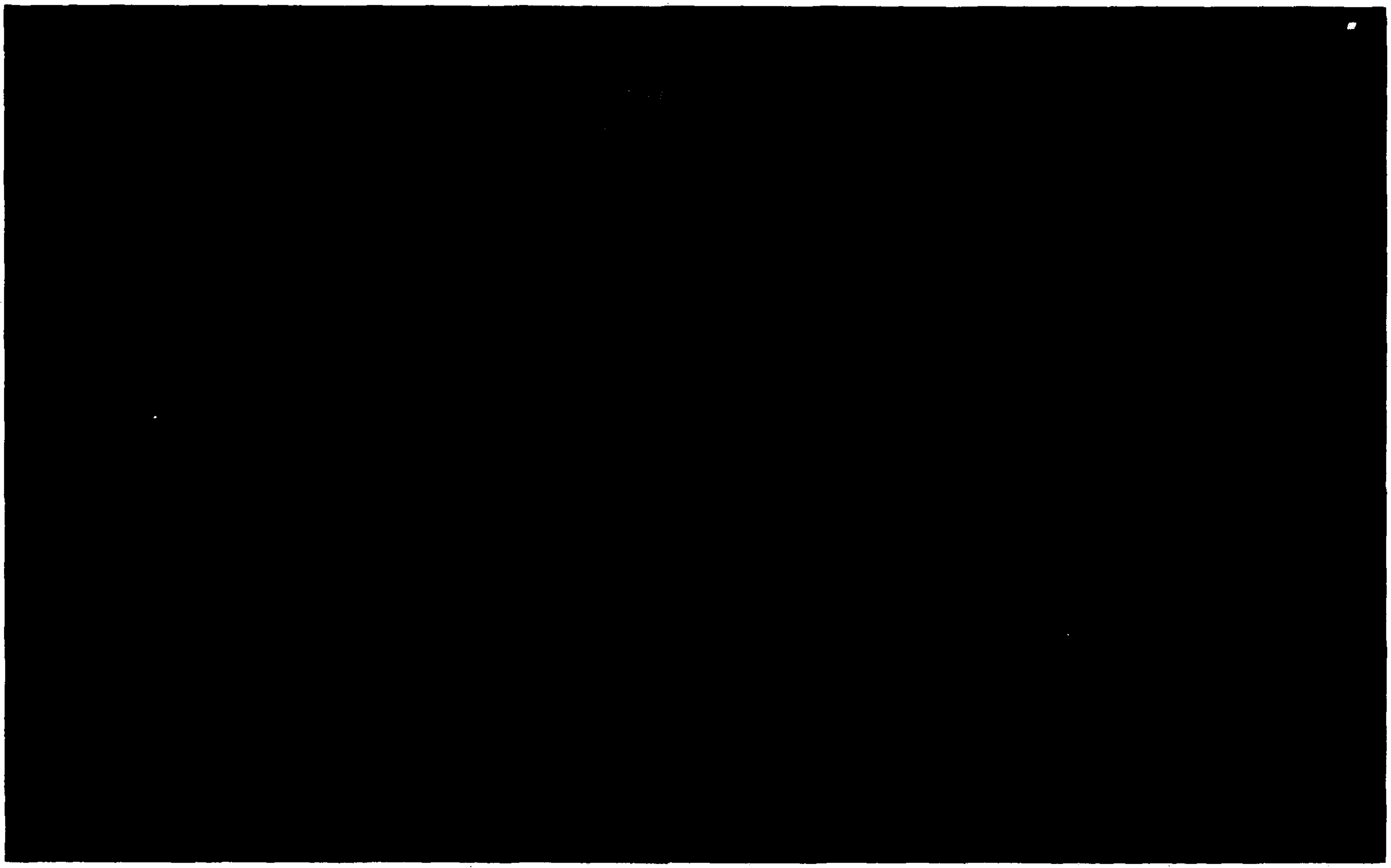


Photo 291. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 6D; swl = +6.7 ft

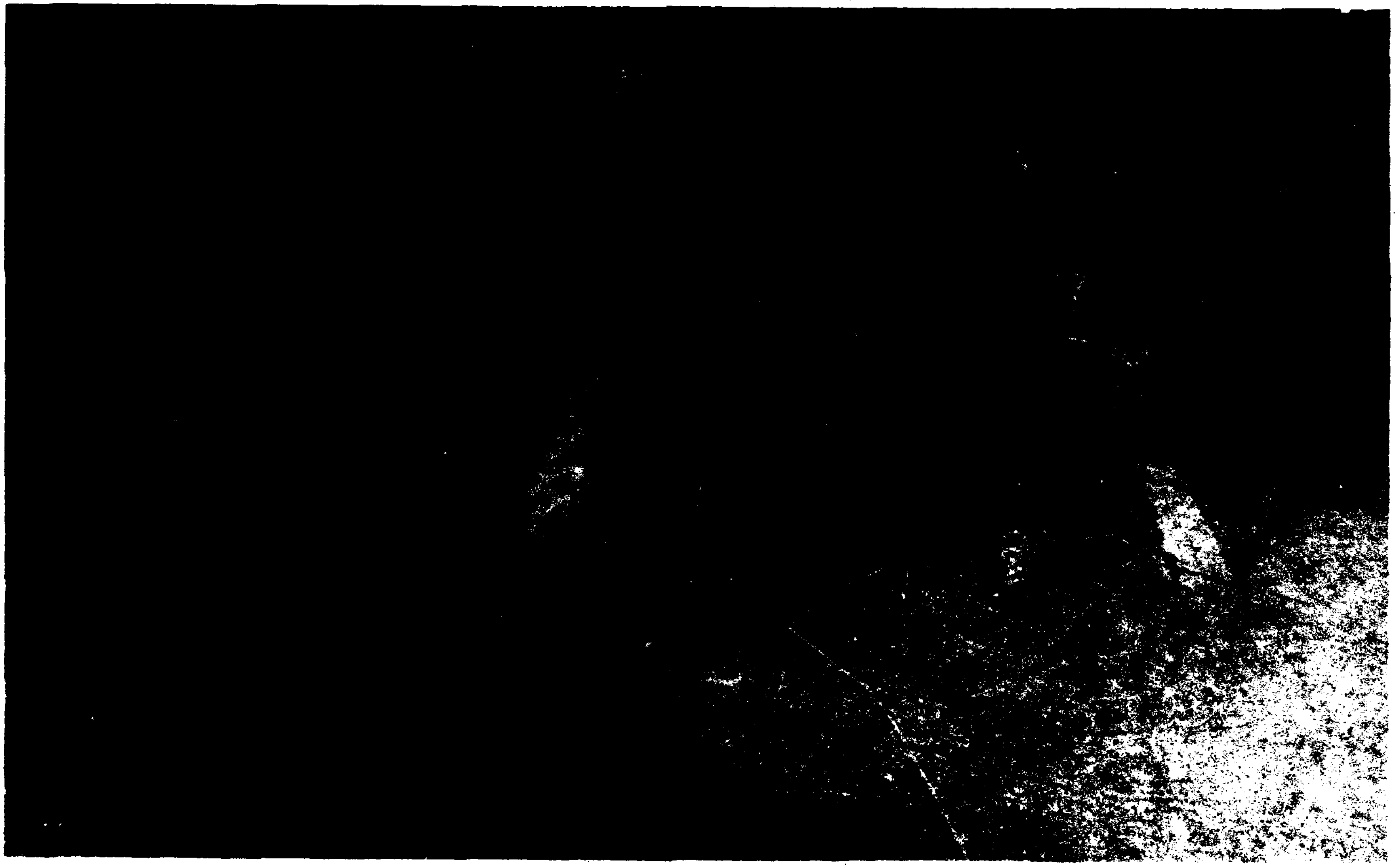


Photo 292. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 6D; swl = 0.0 ft

Photo 293. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 6D; swl = 0.0 ft

Photo 294. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 6D; swl = 0.0 ft

Photo 295. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 7; swl = +6.7 ft

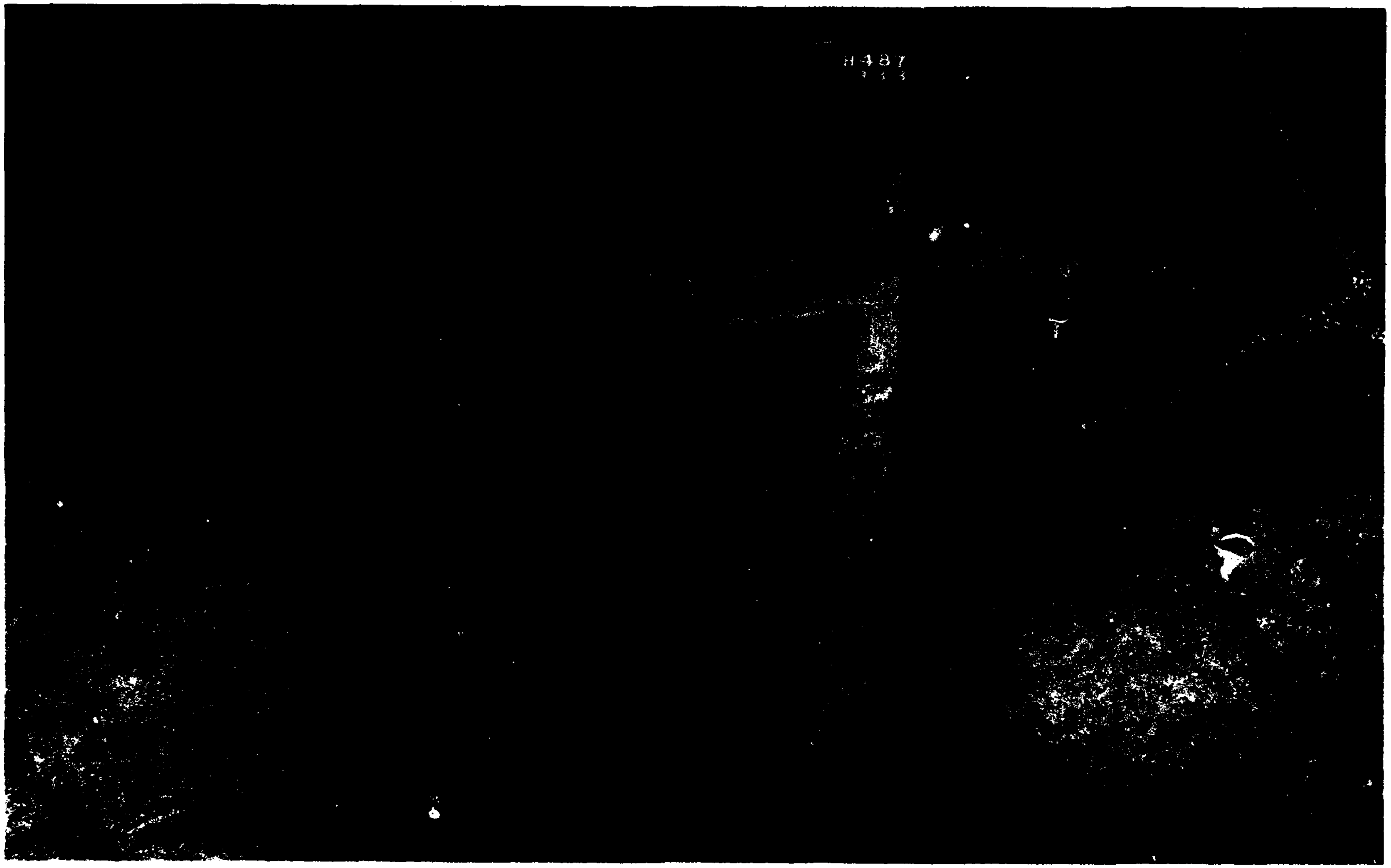


Photo 296. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7A; swl = +6.7 ft

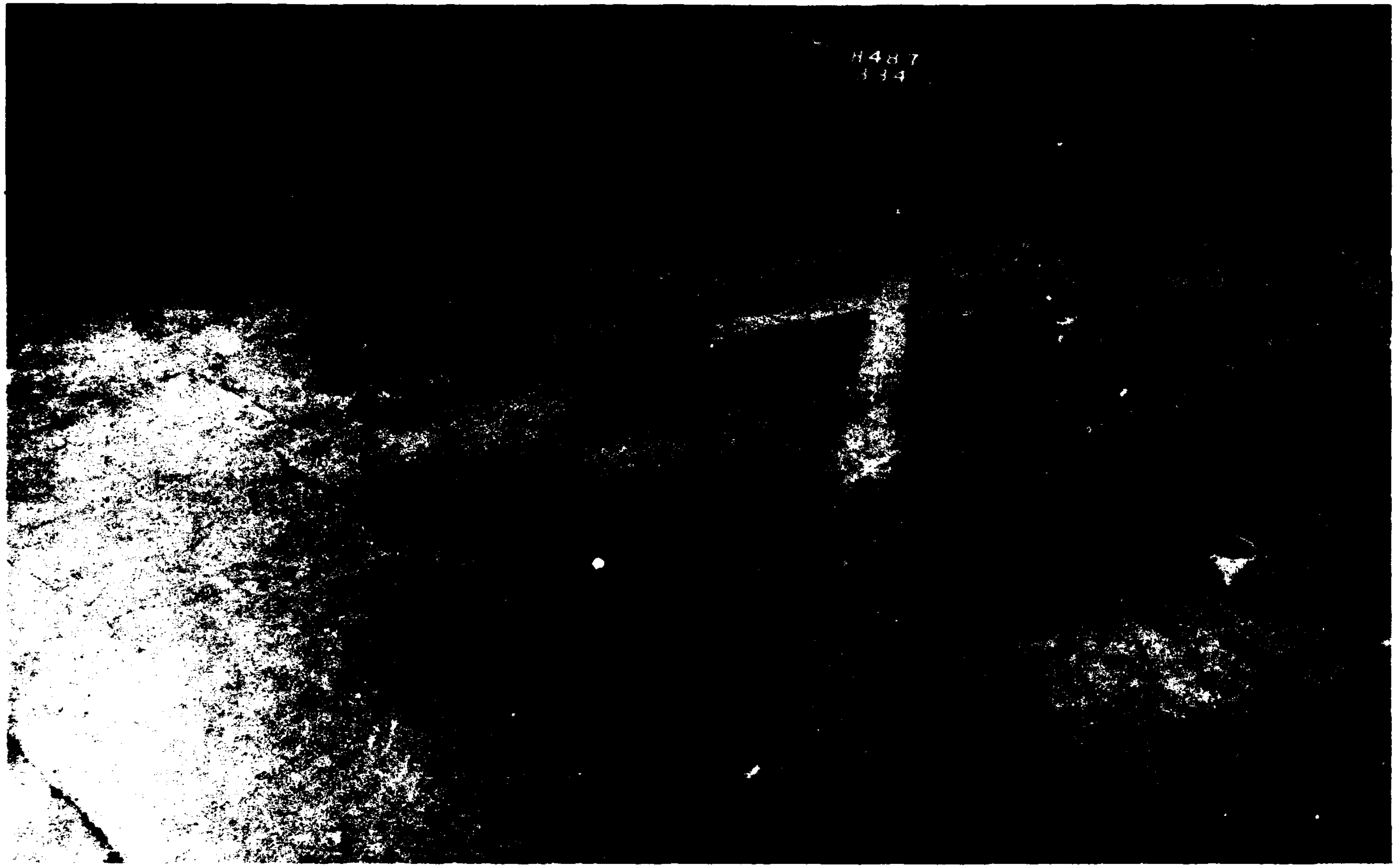


Photo 297. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7B; swl = +6.7 ft

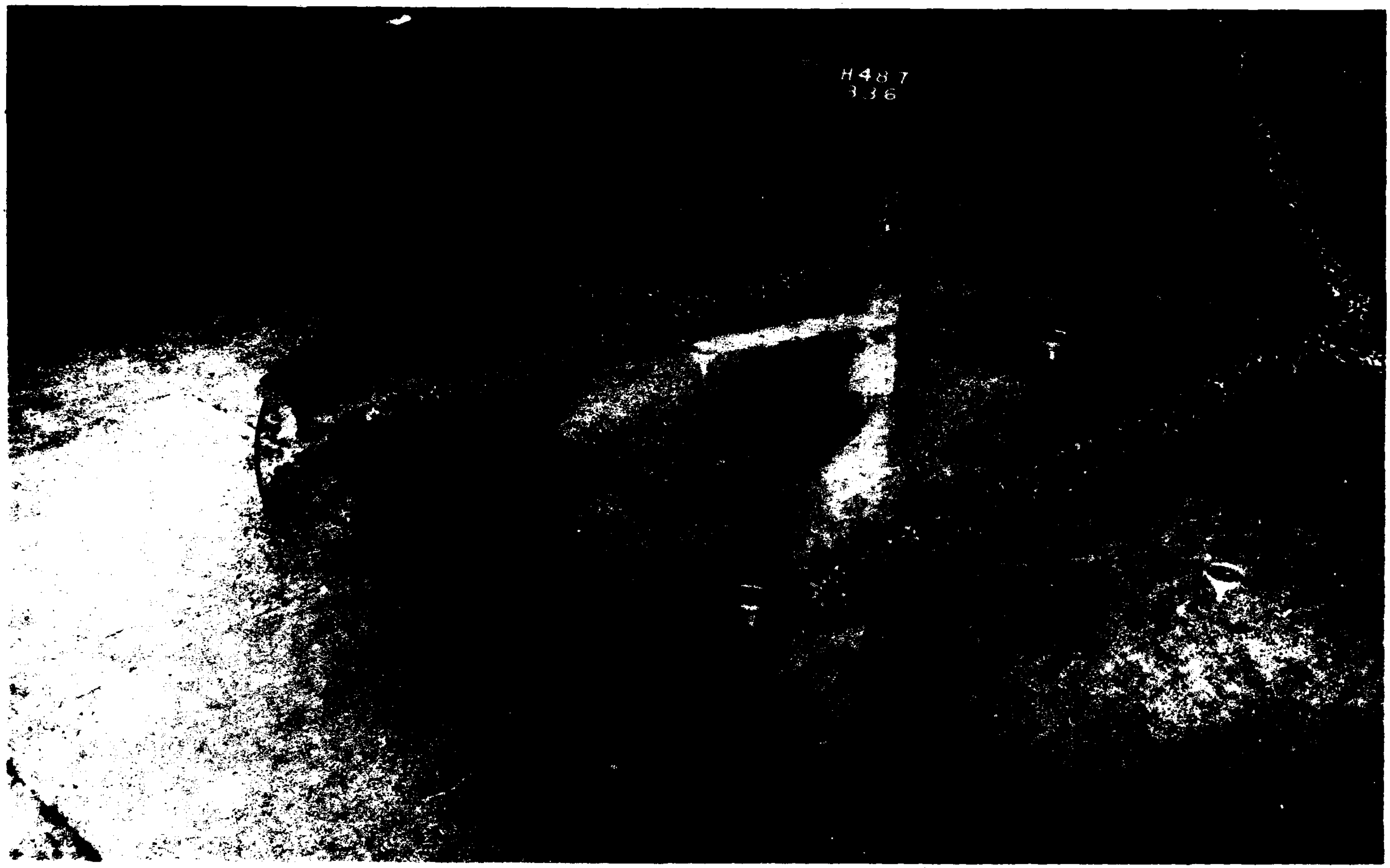


Photo 298. General movement of tracer material and deposits resulting from 11 sec, 12-ft waves from NNW for Plan 7B; swl = 0.0 ft

Photo 299. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7C; swl = 0.0 ft

Photo 300. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7D; swl = 0.0 ft

Photo 301. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7E; swl = 0.0 ft

Photo 302. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7F; swl = 0.0 ft

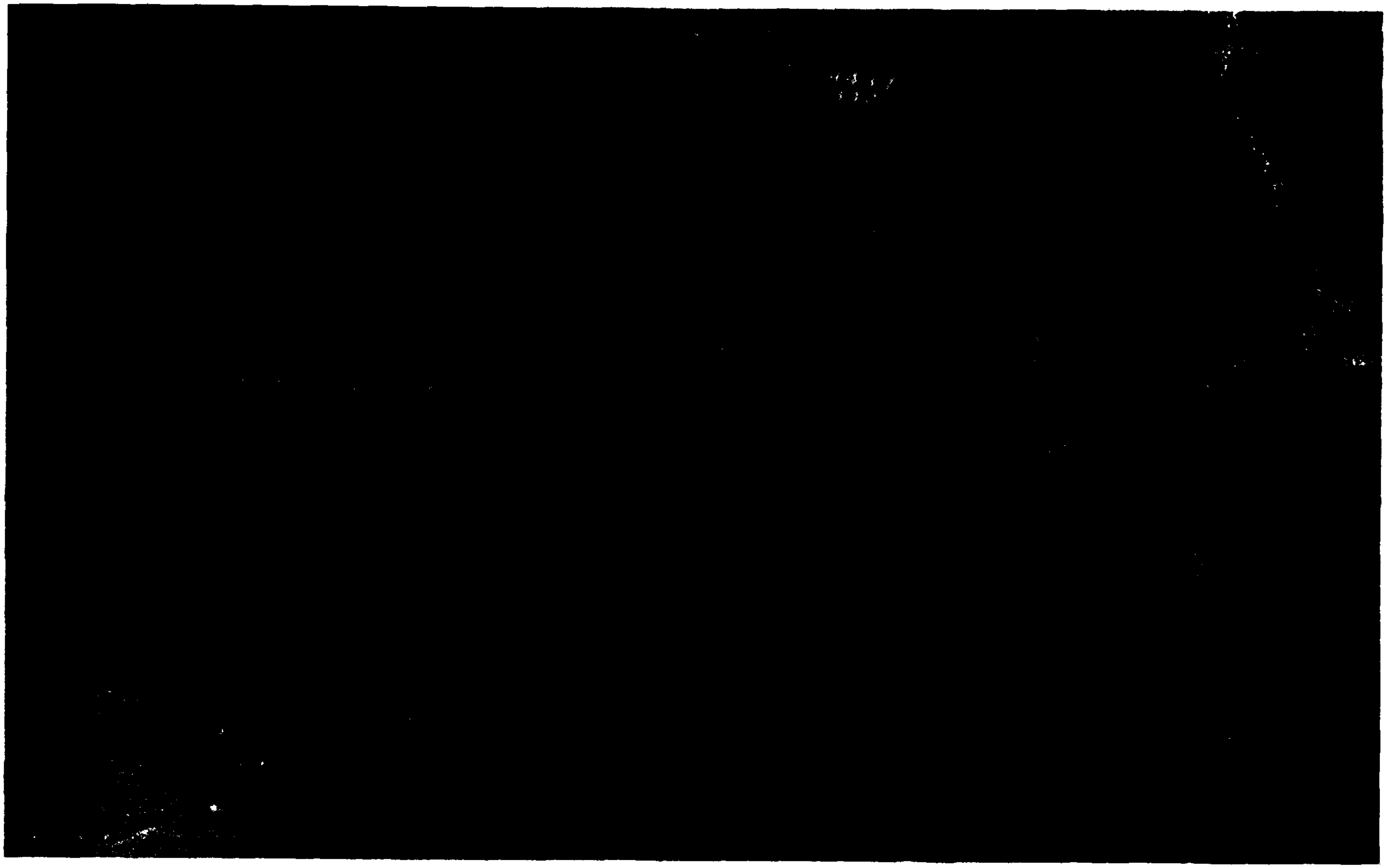


Photo 303. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7G; swl = 0.0 ft

Photo 304. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7H; swl = 0.0 ft

Photo 305. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7I; swl = 0.0 ft

Photo 306. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7J; swl = 0.0 ft

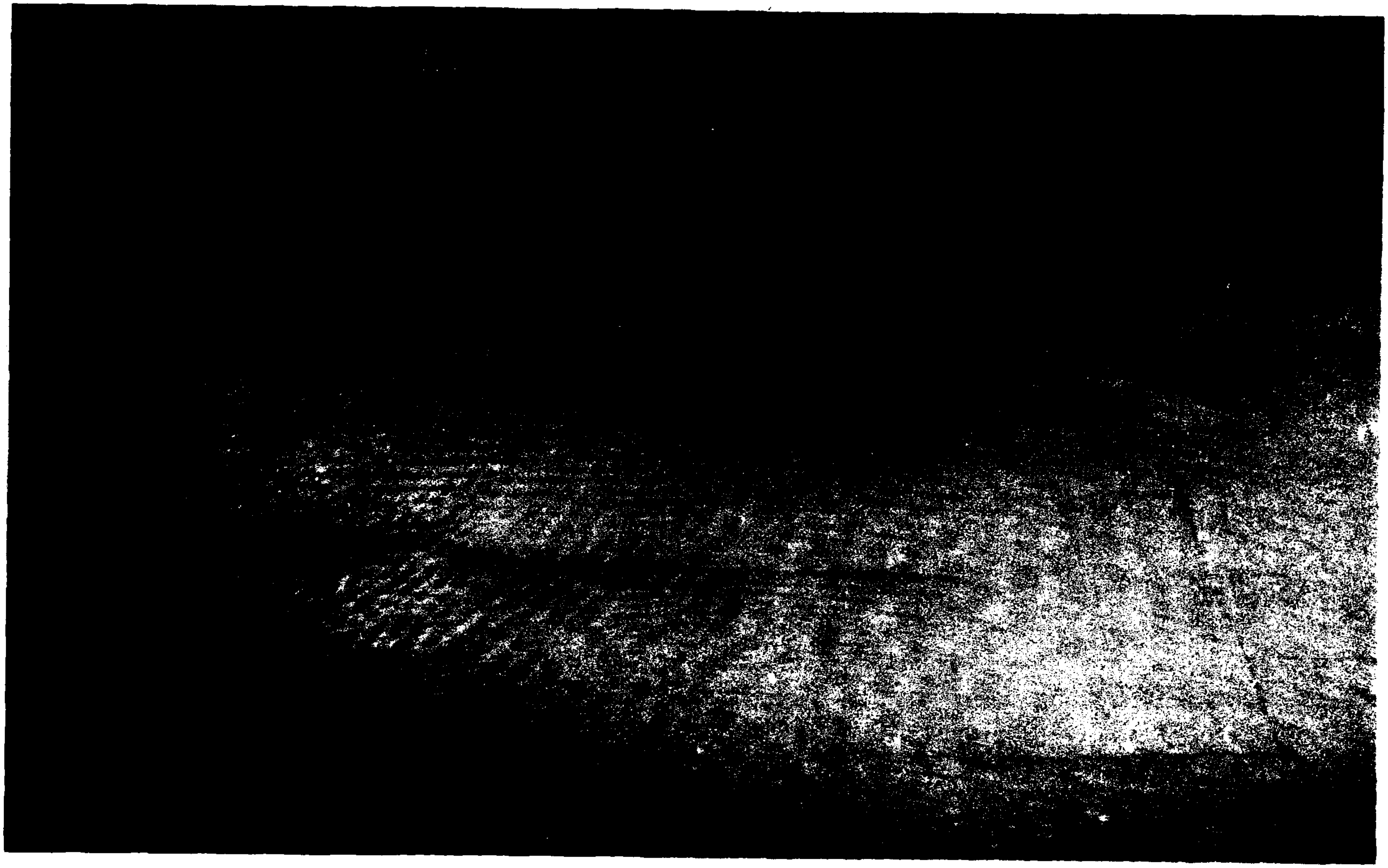


Photo 307. General movement of tracer material and deposits resulting from 11-ft, 12-ft waves from NNW for Plan 7J; swl = 0.0 ft

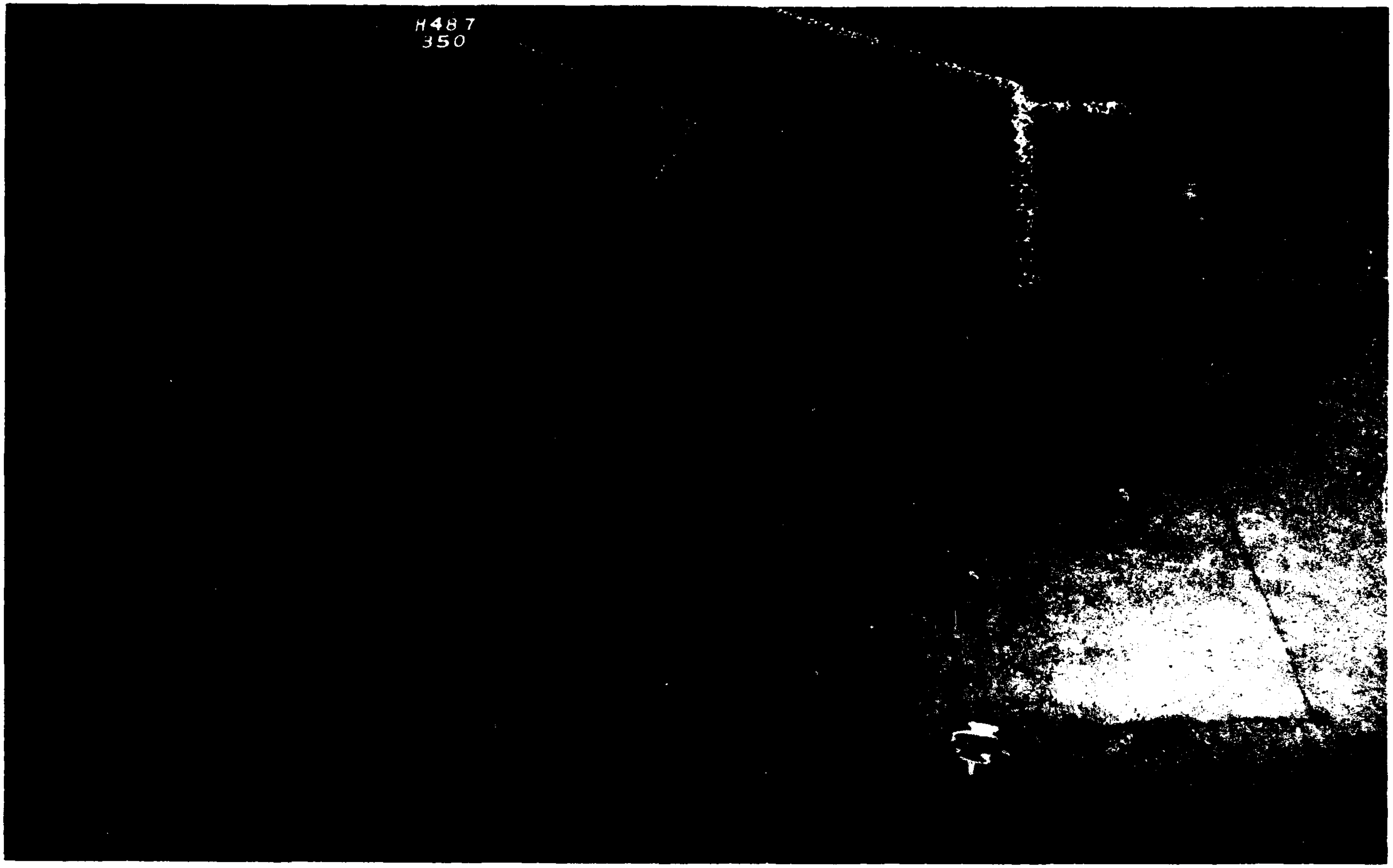


Photo 308. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum ebb for Plan 7J; swl = +1.5 ft

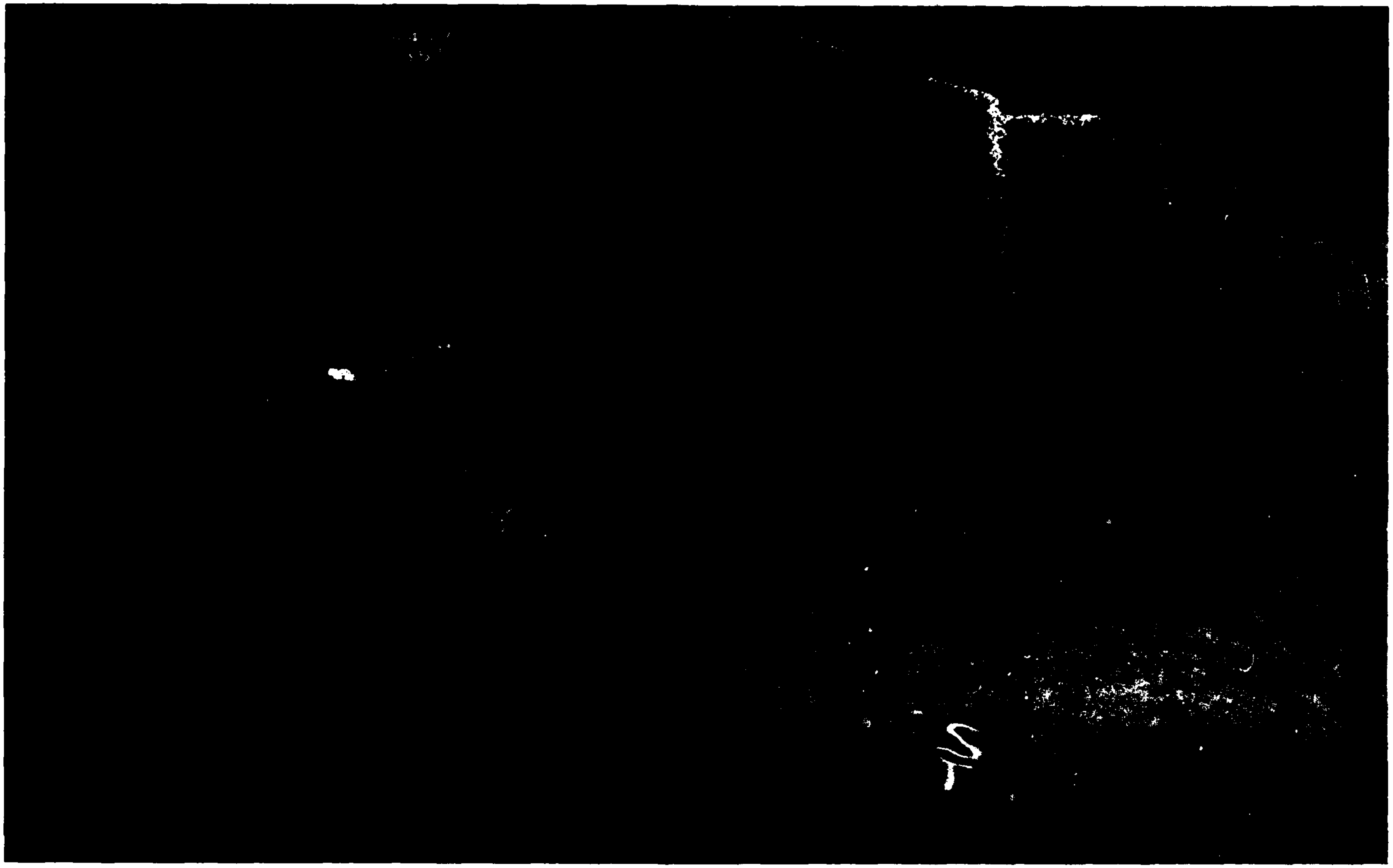


Photo 309. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum flood for Plan 7J; swl = +4.3 ft

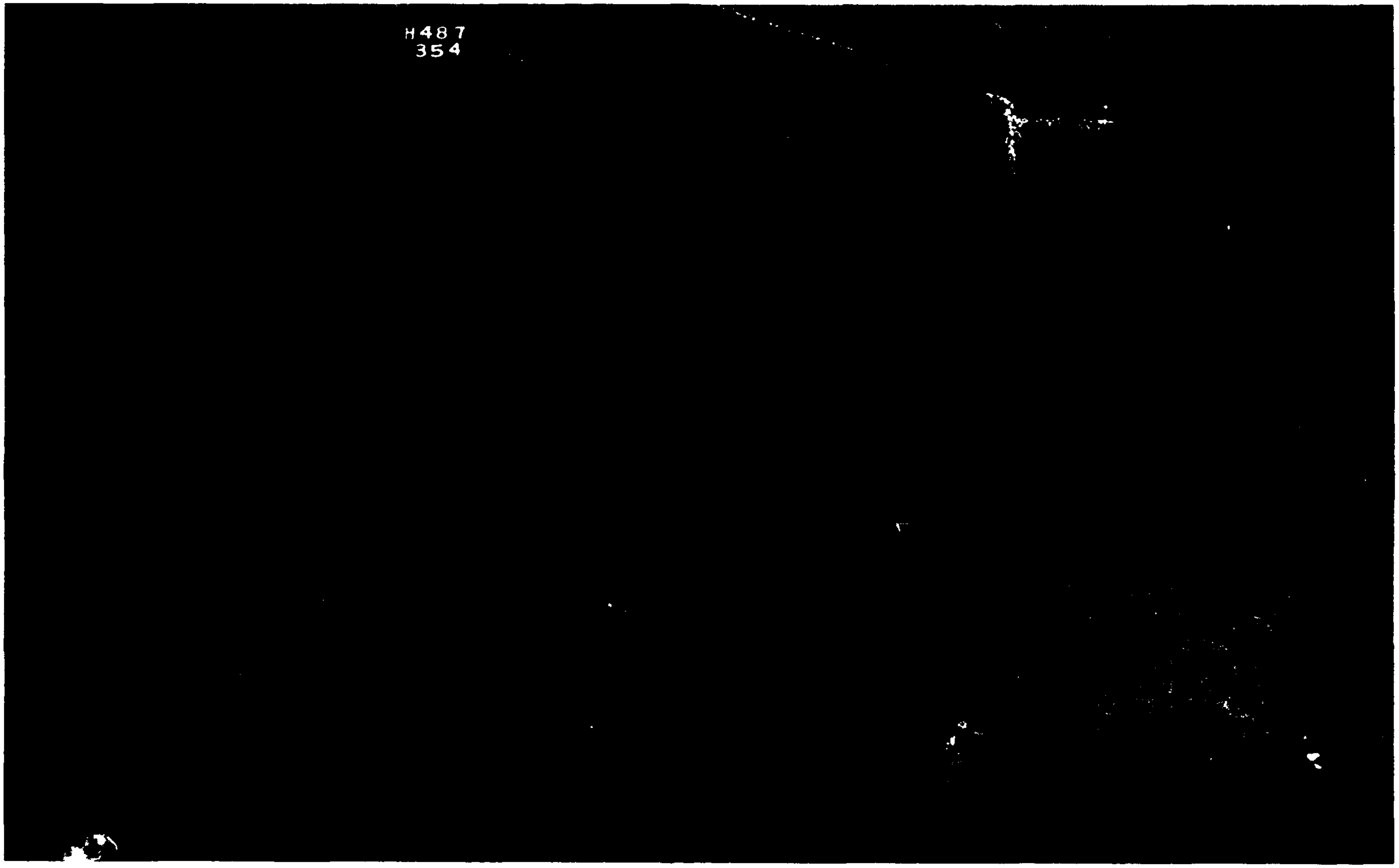


Photo 310. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 7J; swl = +6.7 ft

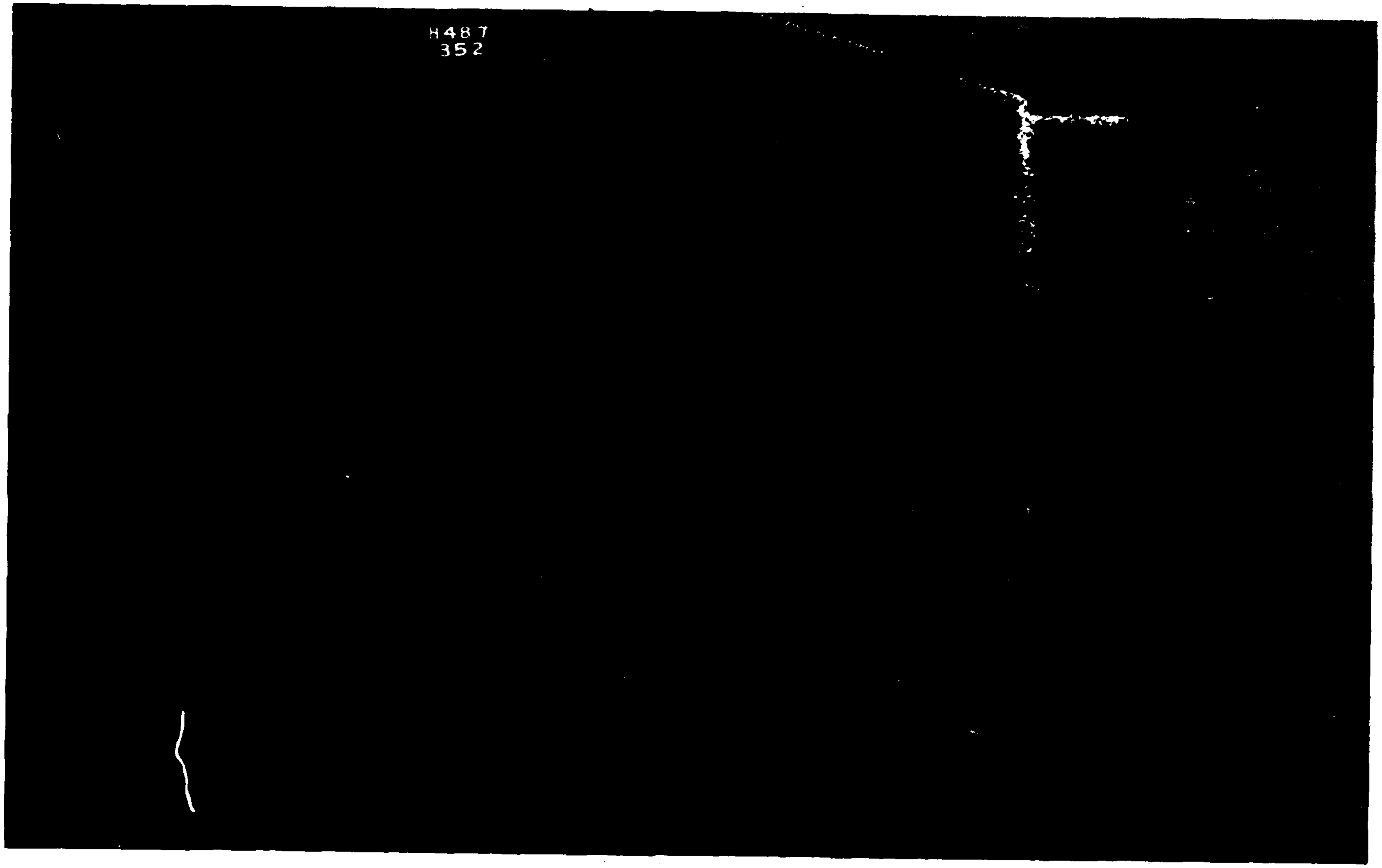


Photo 311. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 7J; swl = +6.7 ft

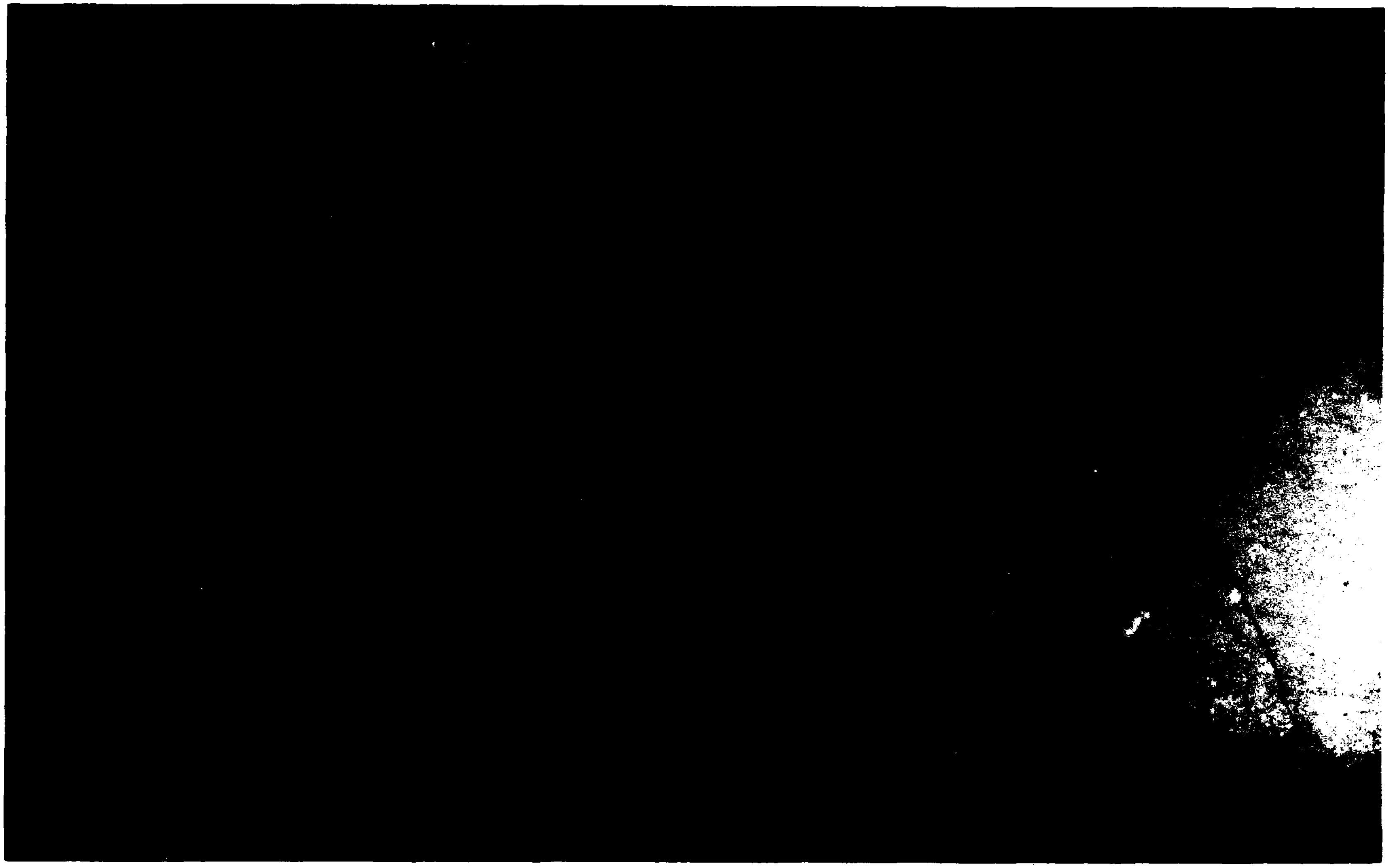


Photo 312. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 7J; swl = +6.7 ft

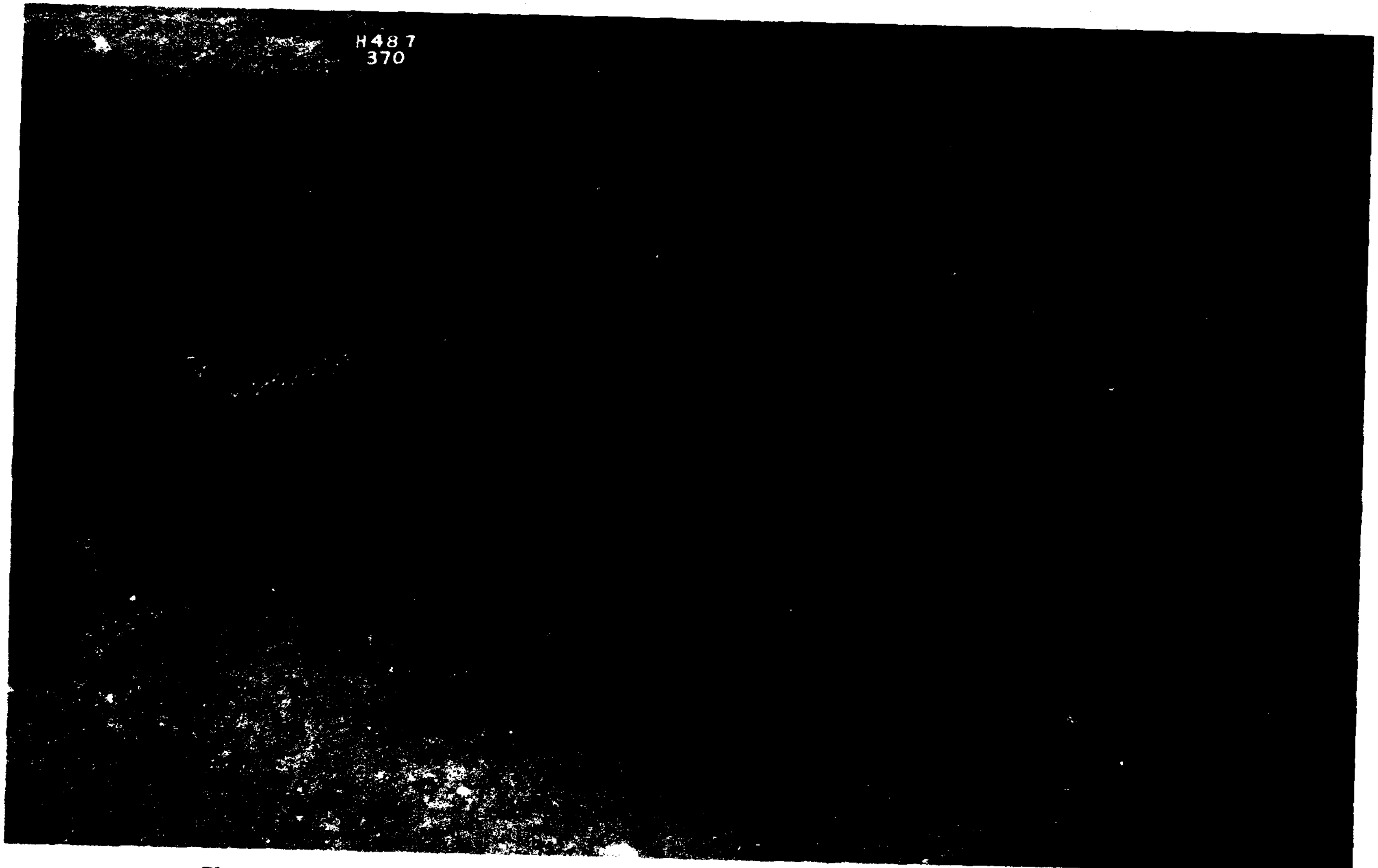


Photo 313. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for Plan 7J; swl = 0.0 ft

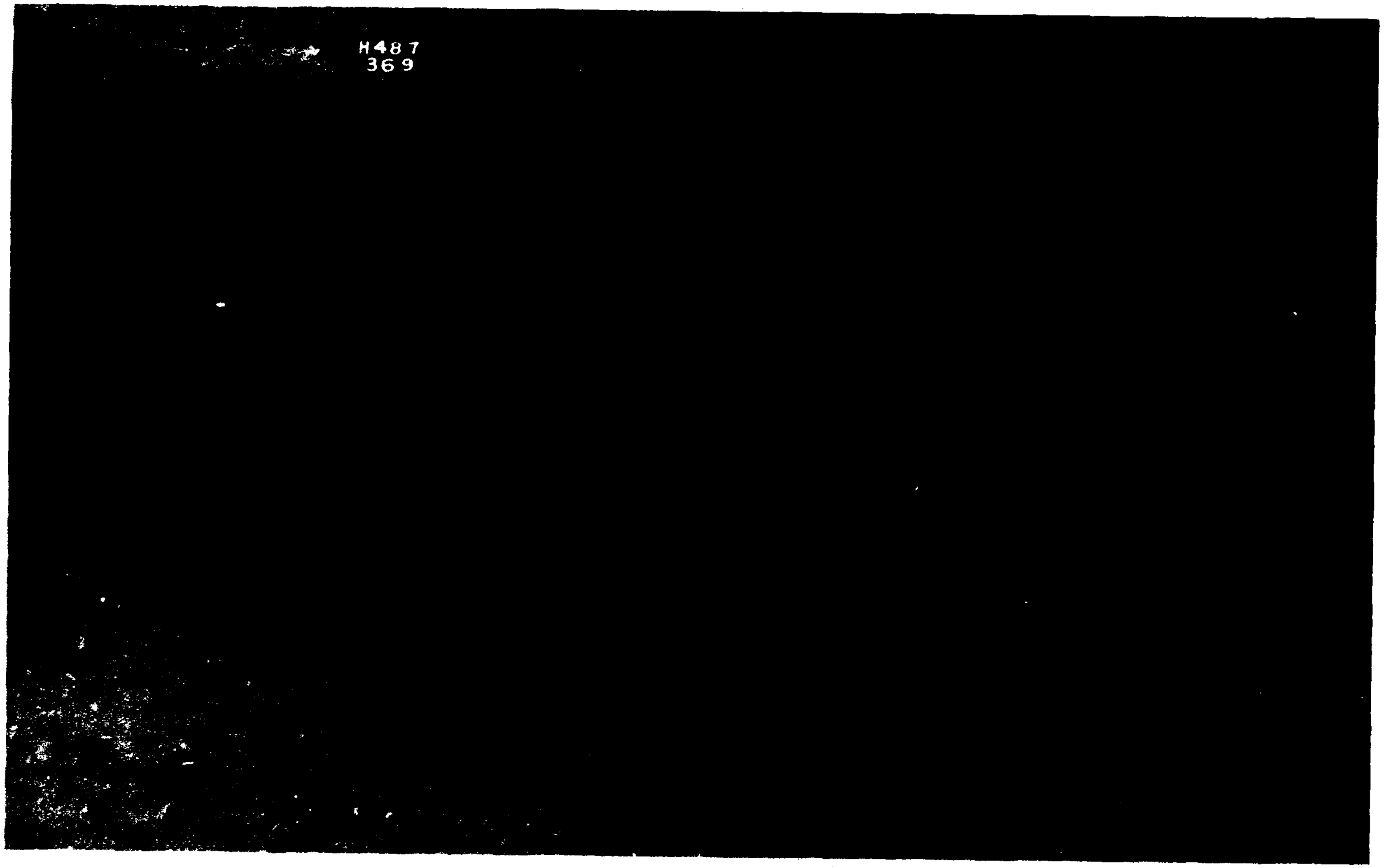


Photo 314. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum ebb for Plan 7J; swl = +1.5 ft

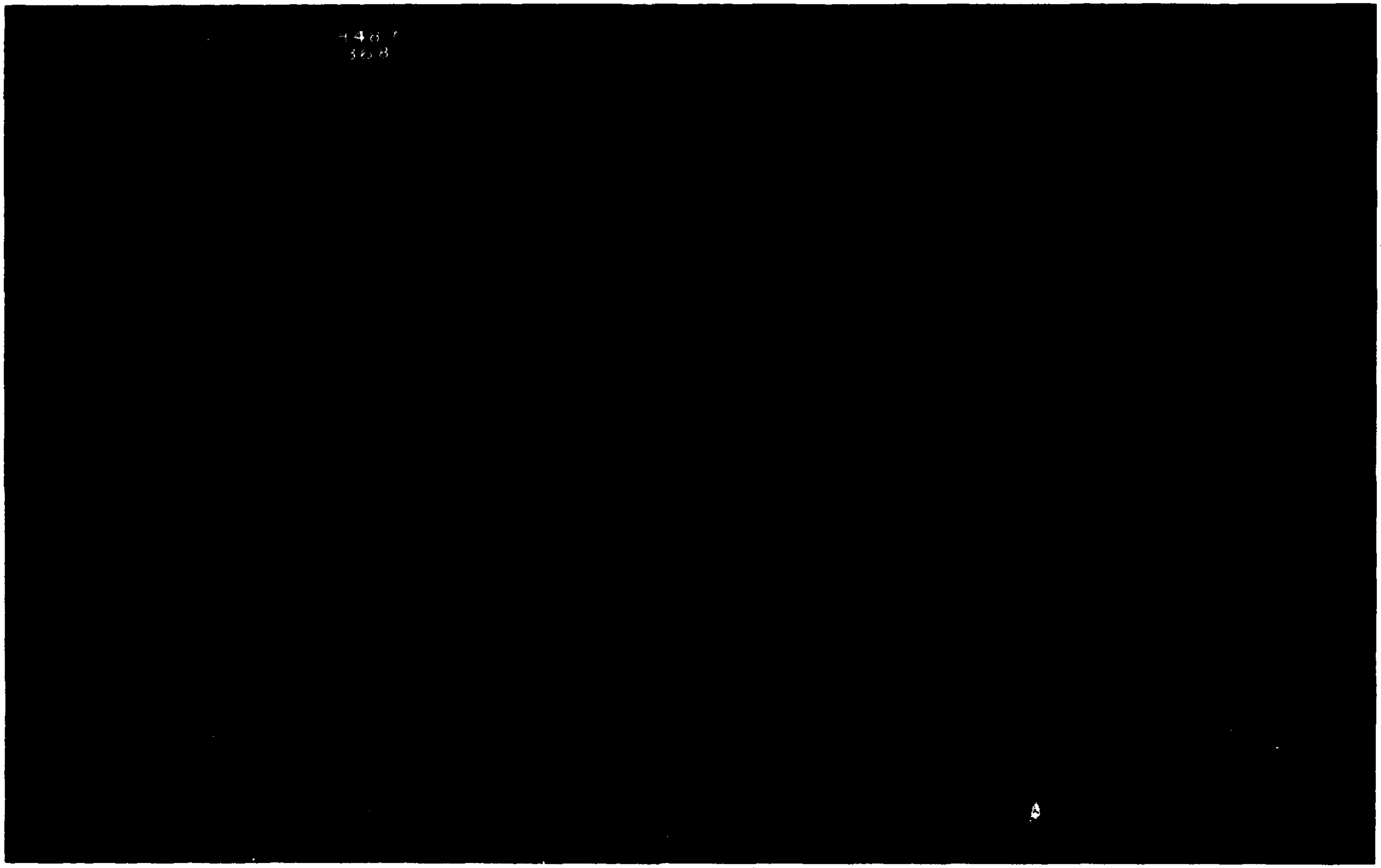


Photo 315. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum flood for Plan 7J; swl = +4.3 ft

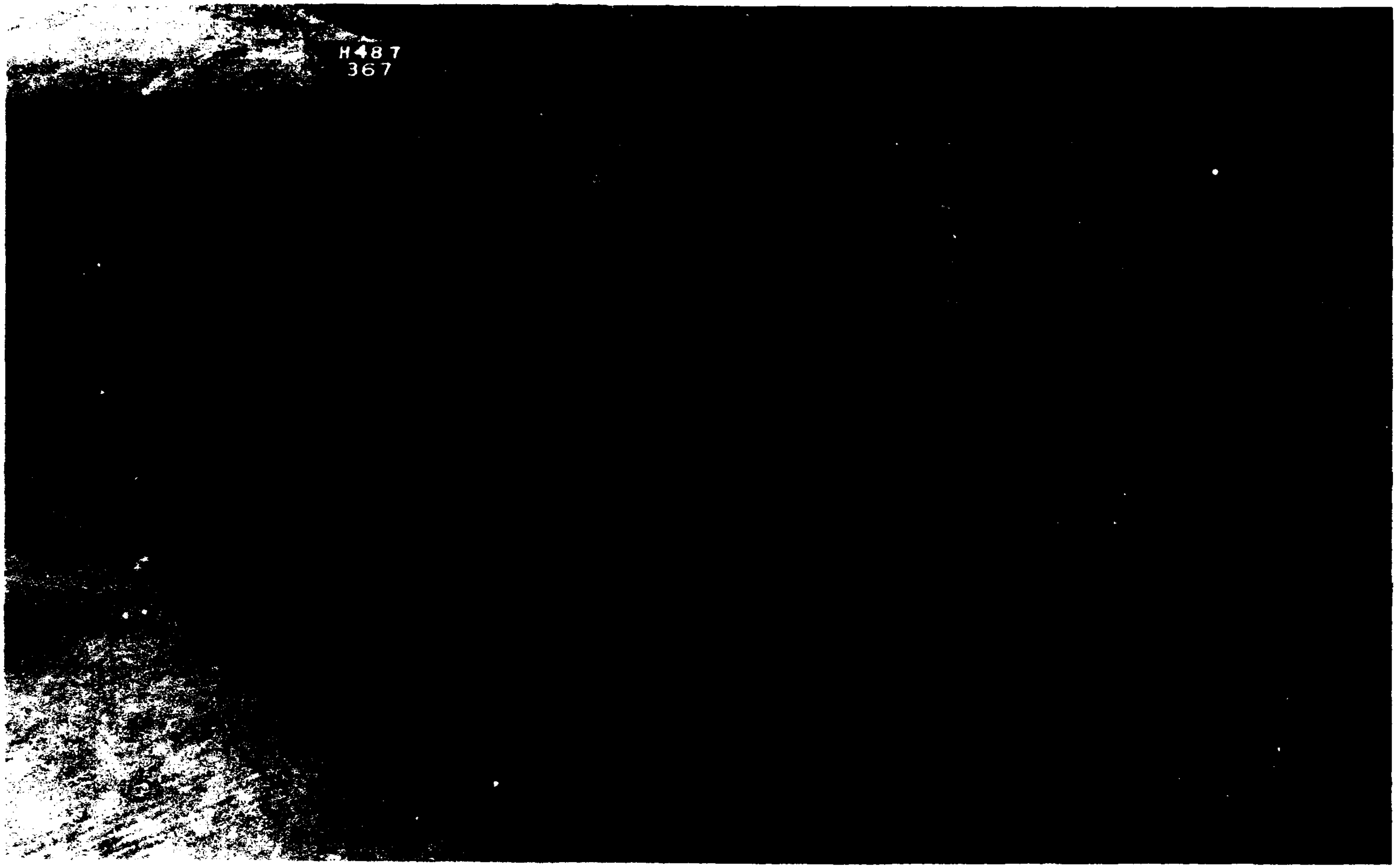


Photo 316. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for Plan 7J; swl = +6.7 ft

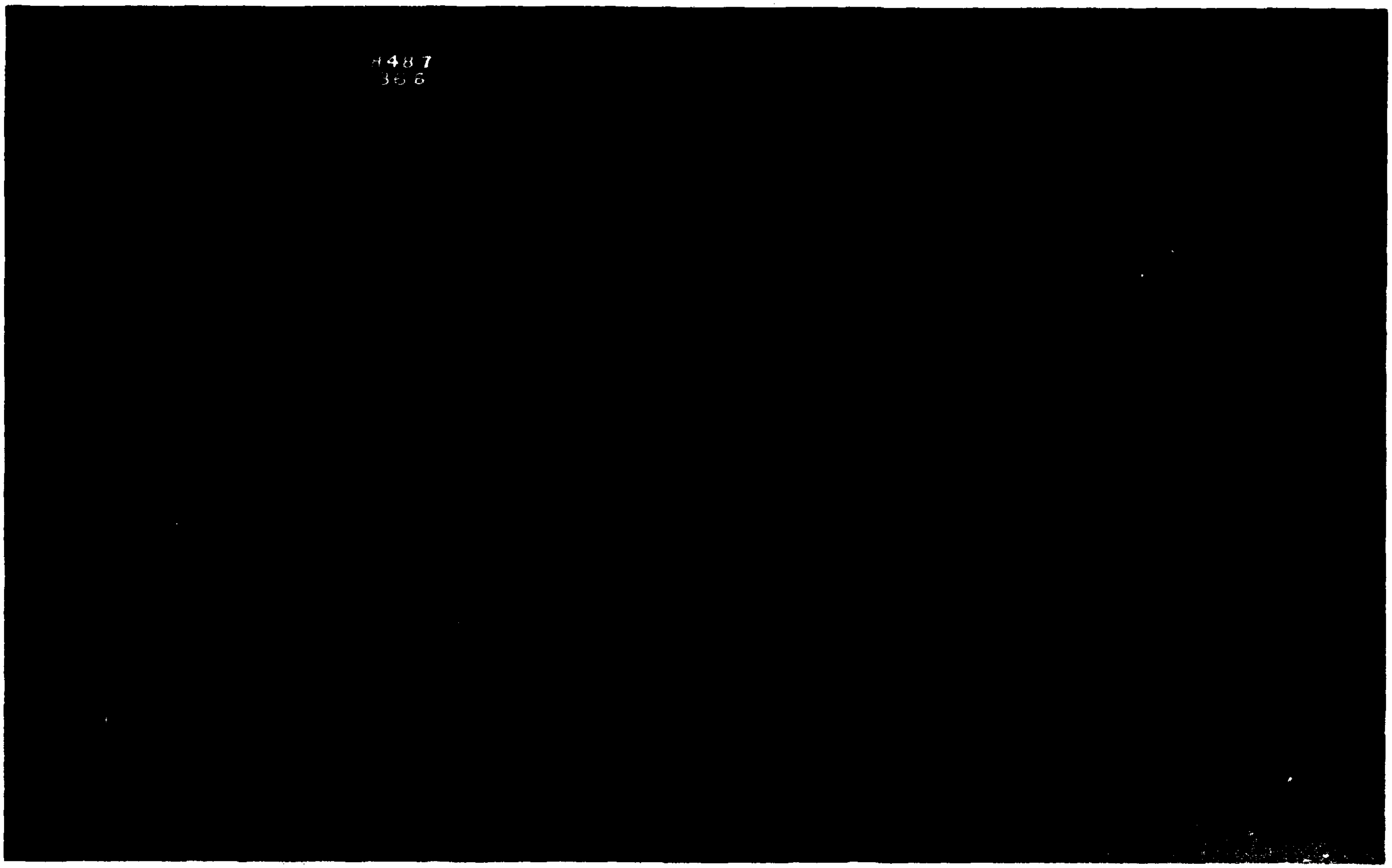


Photo 317. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for Plan 7J; swl = +6.7 ft

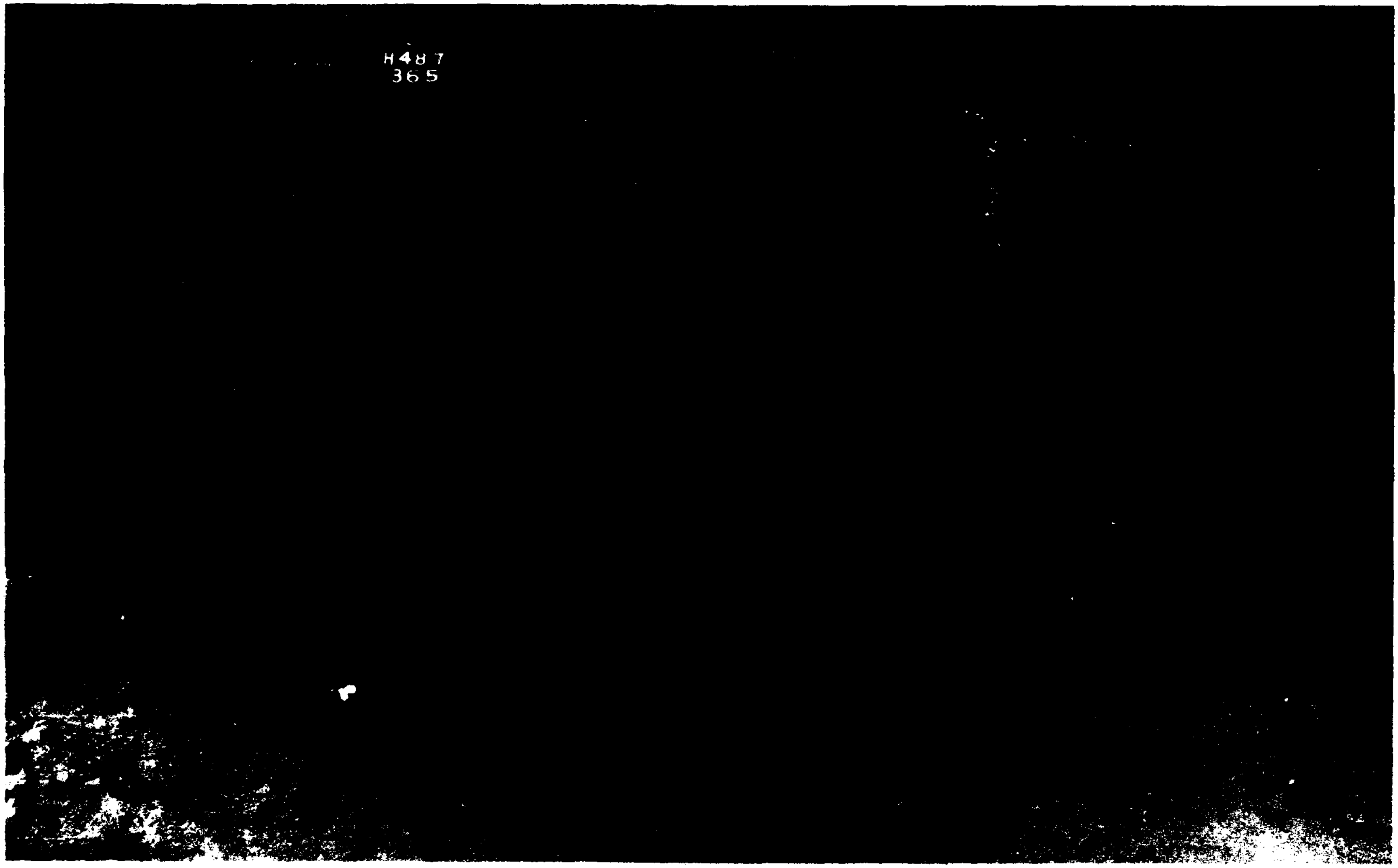


Photo 318. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for Plan 7J; swl = +6.7 ft

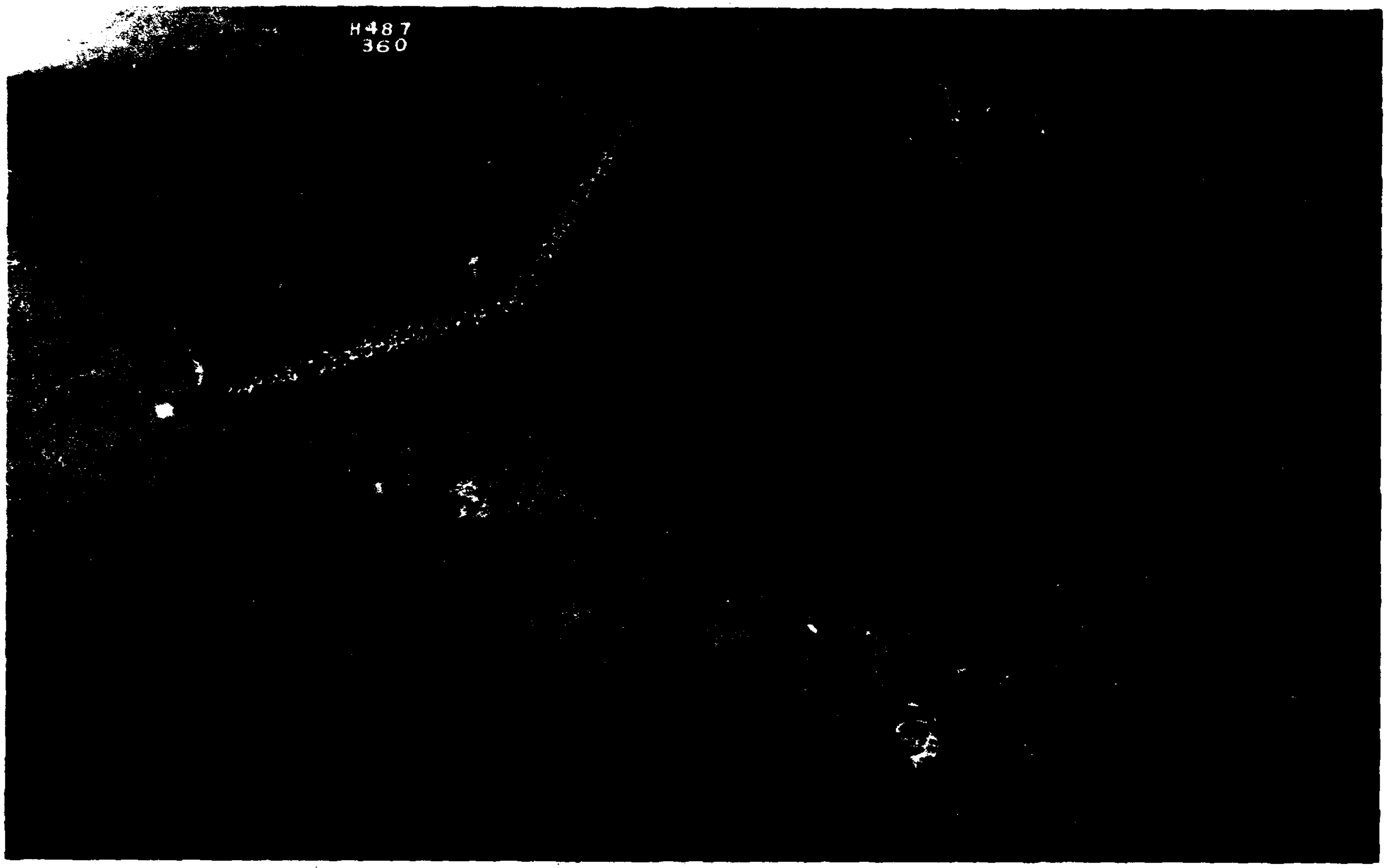


Photo 319. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 7J; swl = 0.0 ft

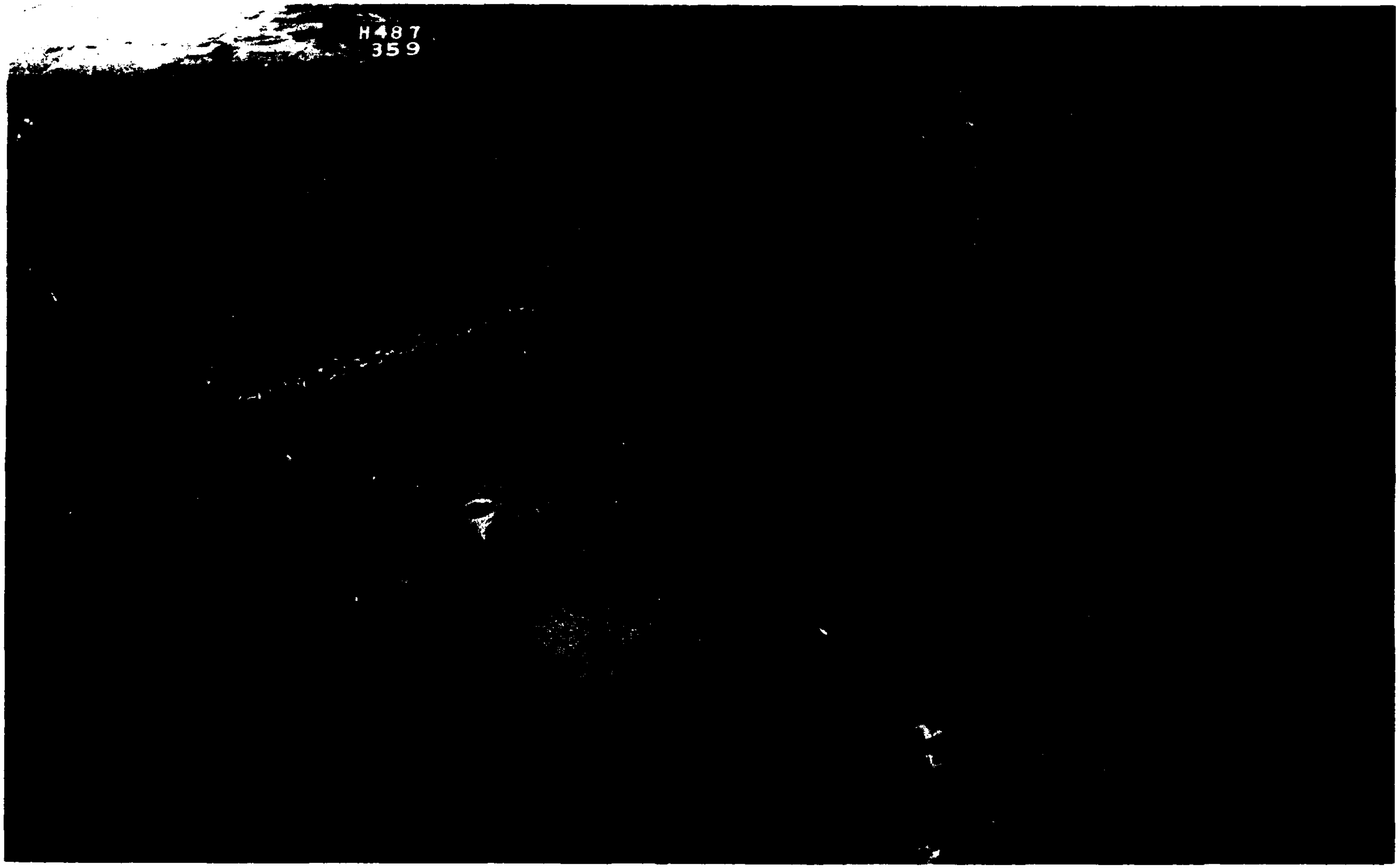


Photo 320. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum ebb for Plan 7J; swl = +1.5 ft

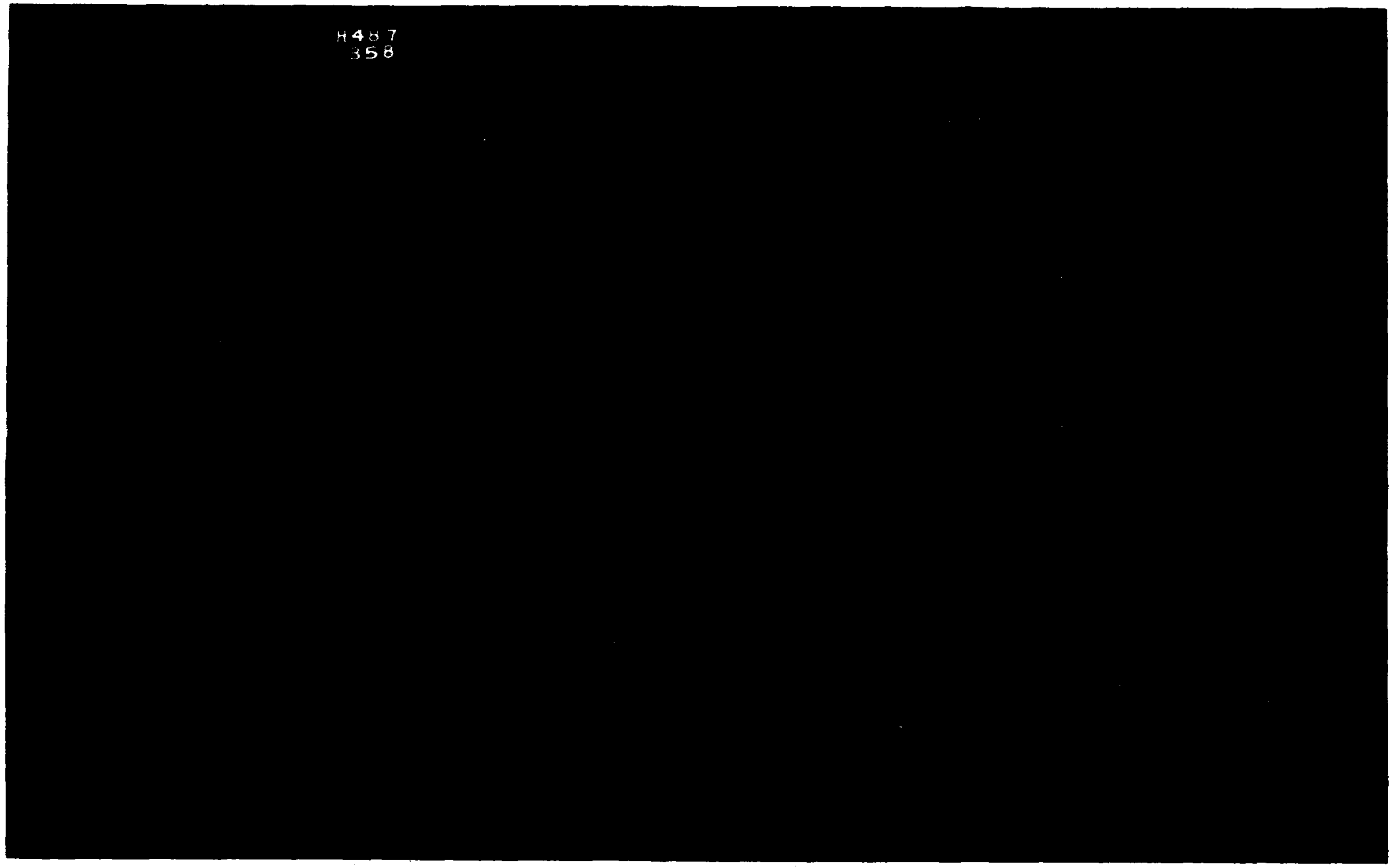


Photo 321. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum flood for Plan 7J; swl = +4.3 ft

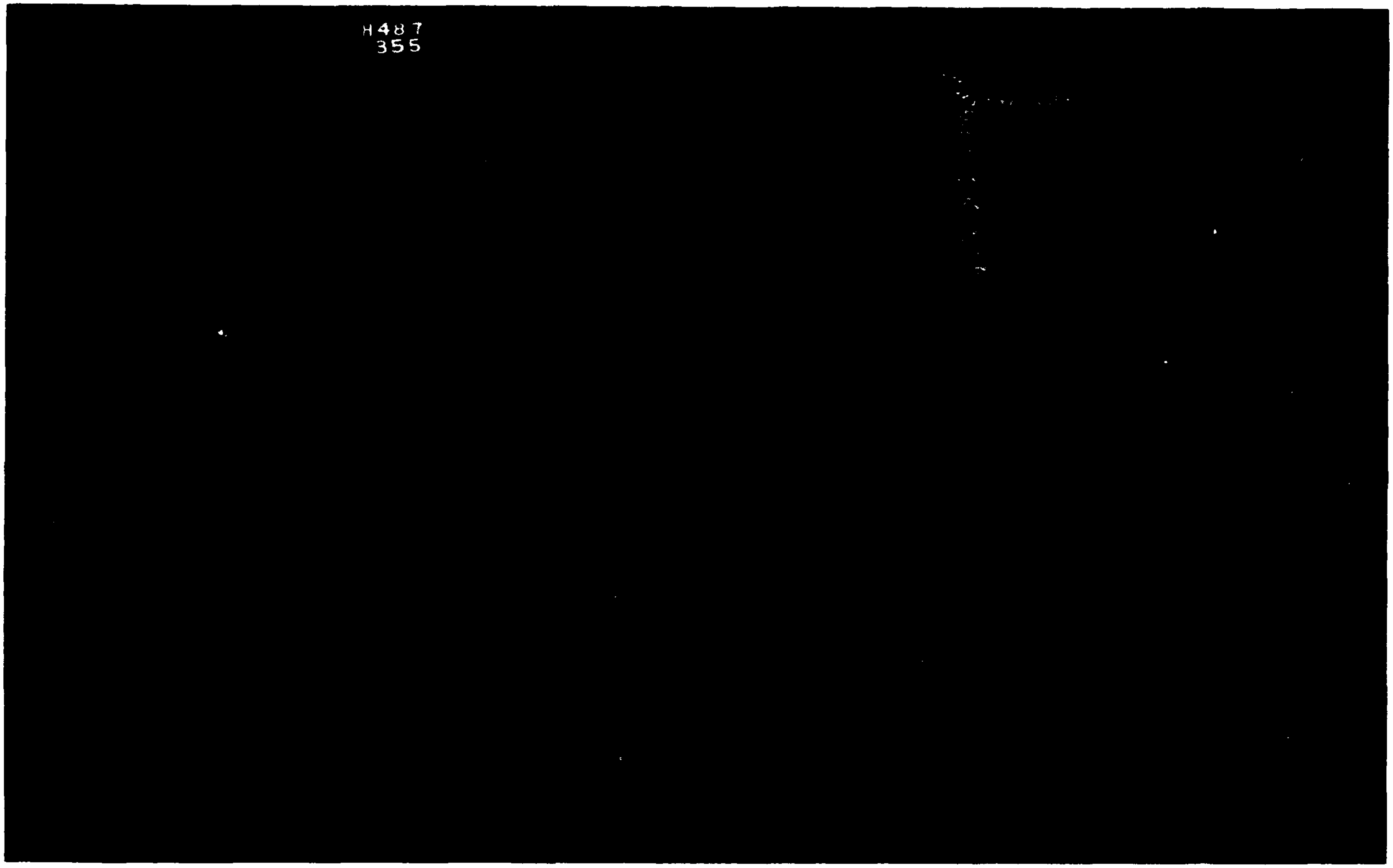


Photo 322. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 7J; swl = +6.7 ft

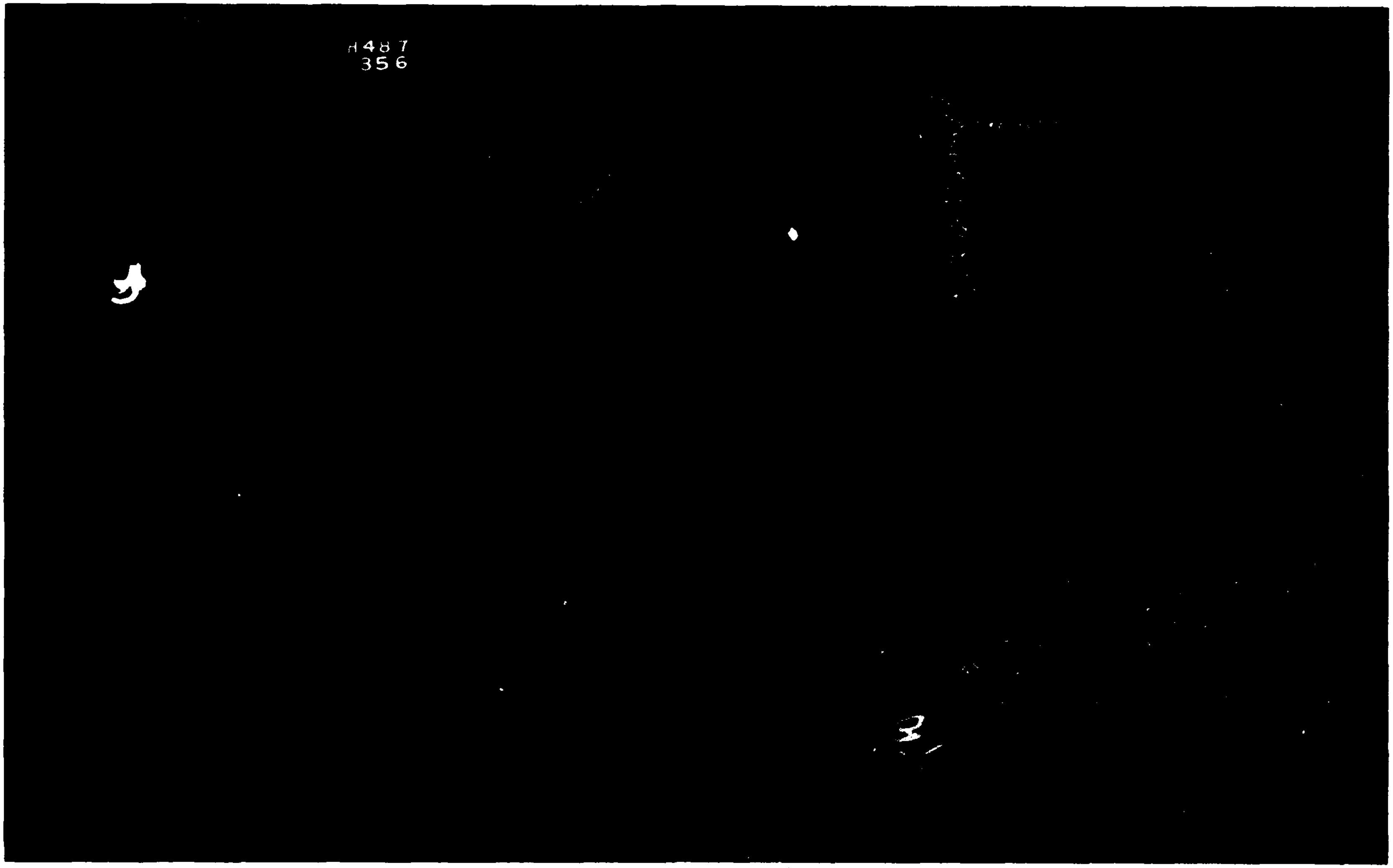


Photo 323. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 7J; swl = +6.7 ft

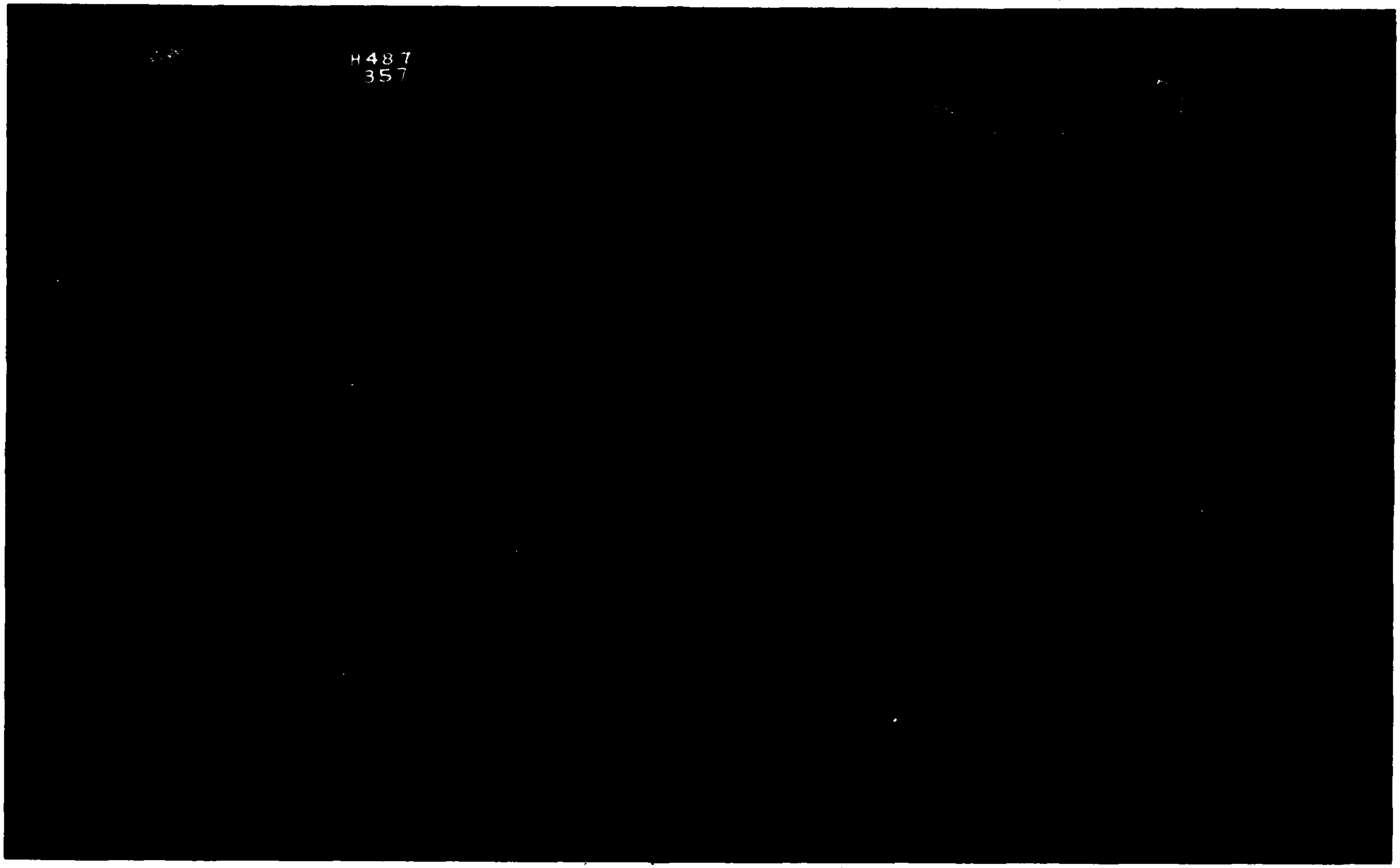


Photo 324. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 7J; swl = +6.7 ft

Photo 325. Typical wave patterns obtained for Plan 7J; 11-sec, 12-ft waves from NNW; swl = +6.7 ft

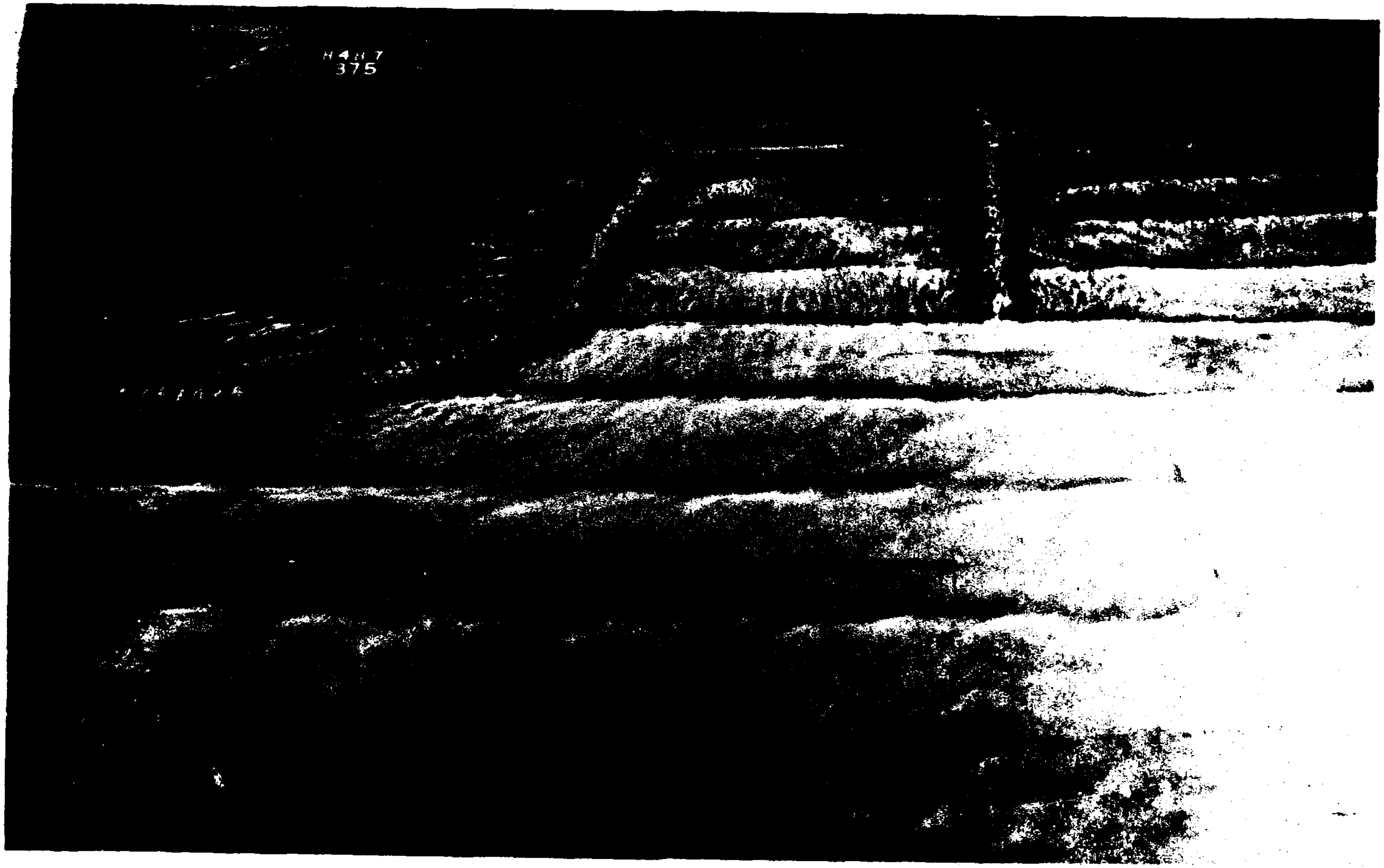


Photo 326. Typical wave patterns obtained for Plan 7J; 11-sec, 12-ft waves from west; swl = +6.7 ft

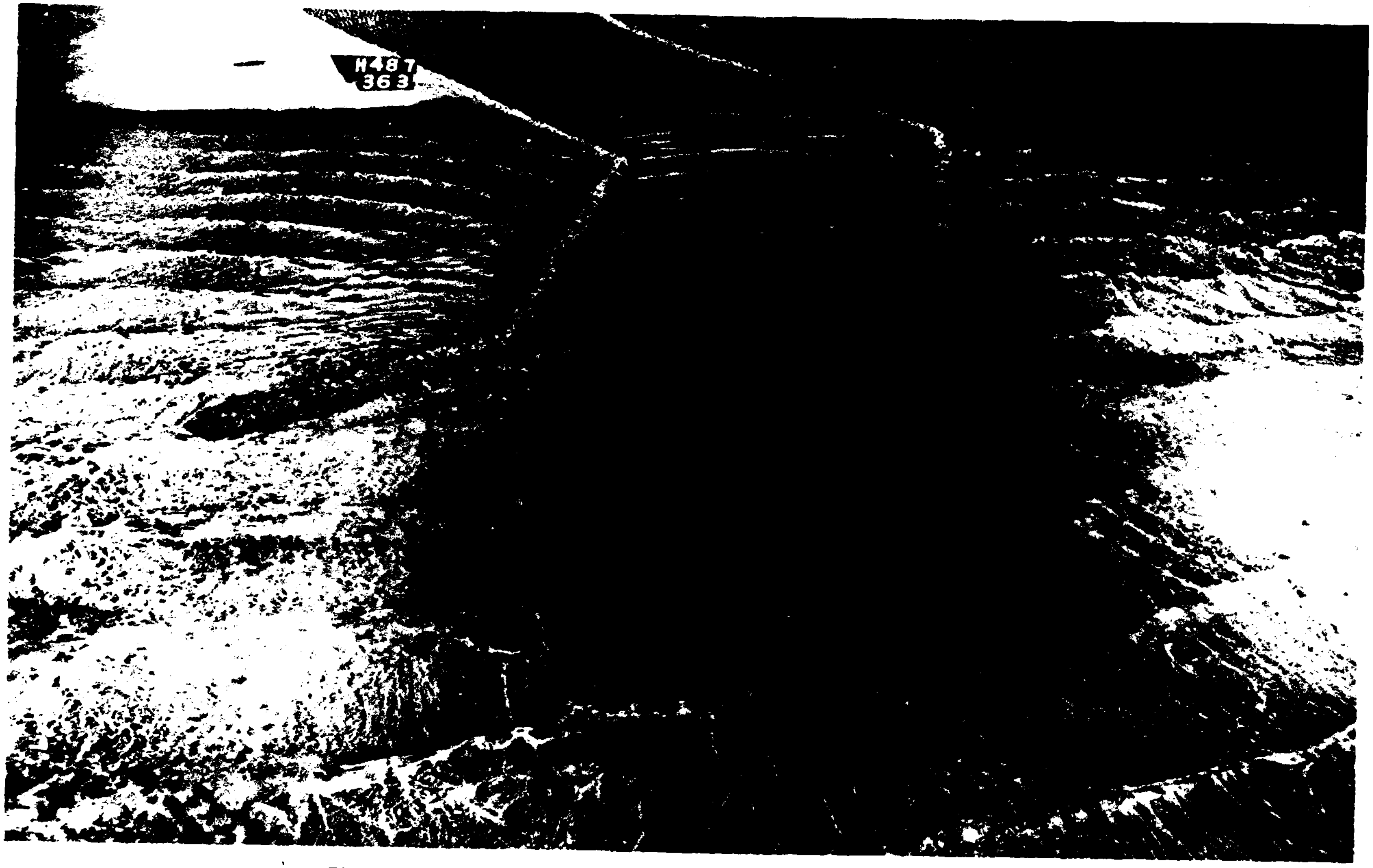


Photo 327. Typical wave patterns obtained for Plan 7J; 9-sec, 21-ft waves from SW; swl = +6.7 ft

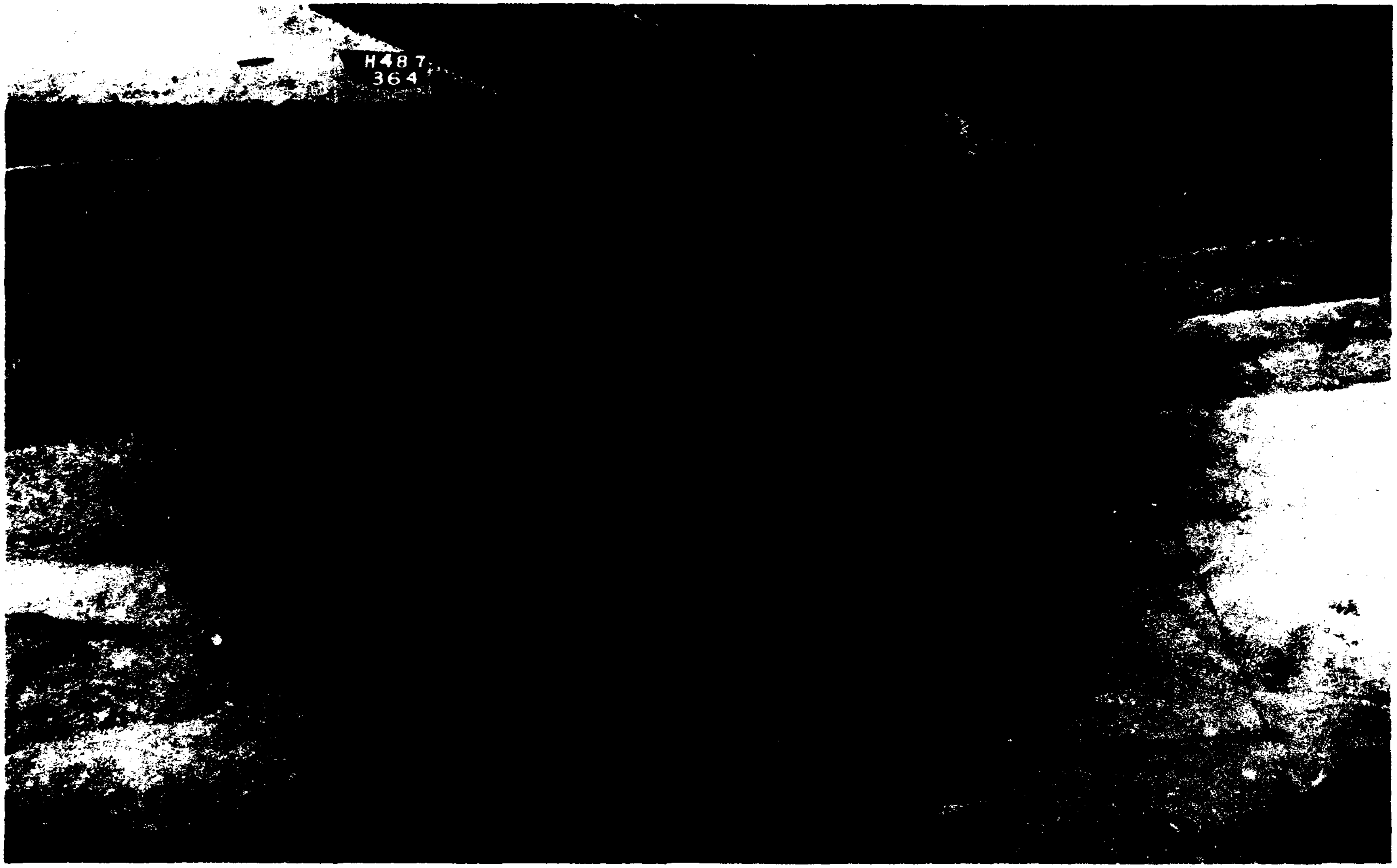


Photo 328. Typical wave patterns obtained for Plan 7J; 13-sec, 7-ft waves from SW; swl = +6.7 ft

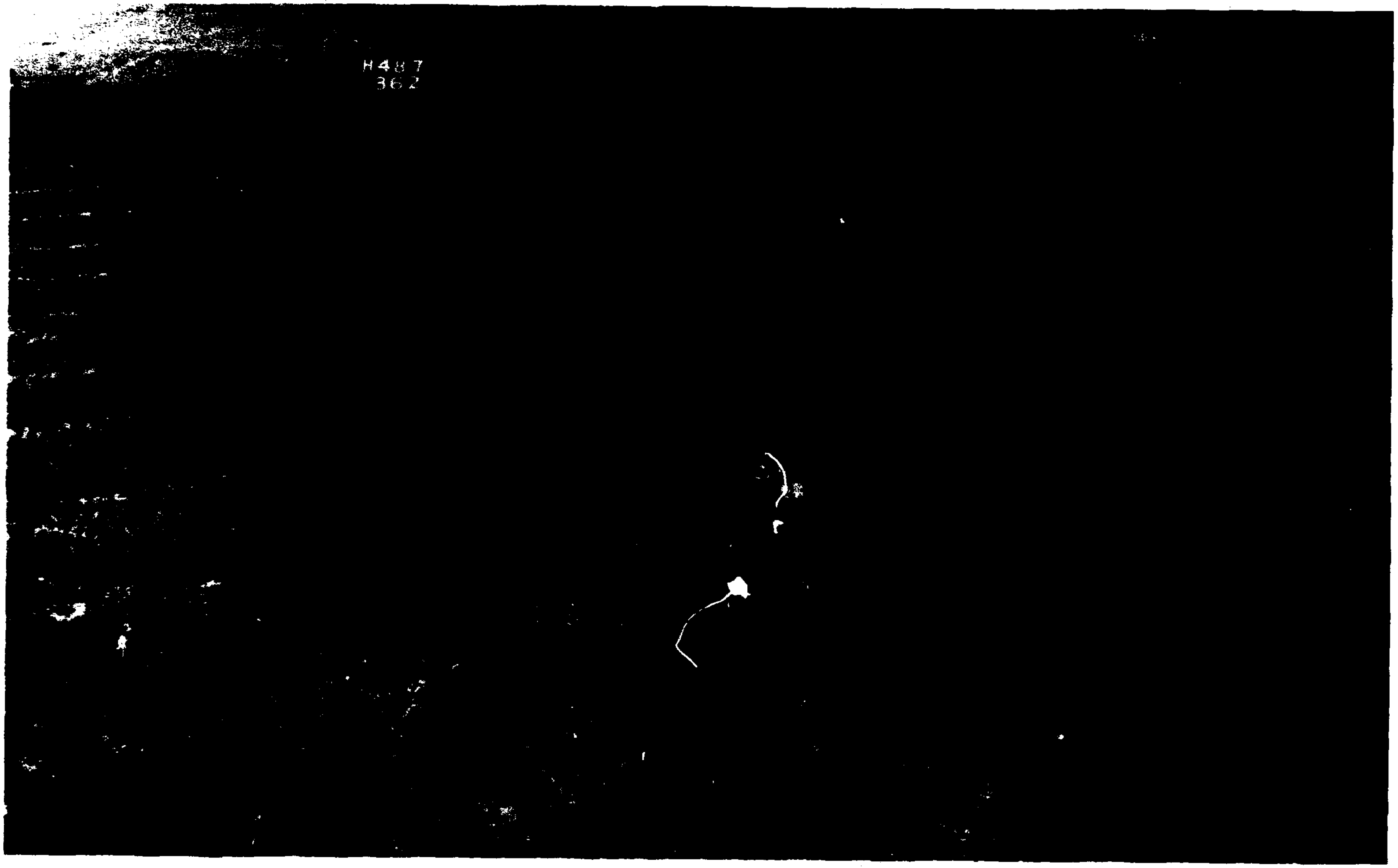


Photo 329. Typical wave patterns obtained for Plan 7J; 9-sec, 27-ft waves from SSW; swl = +6.7 ft

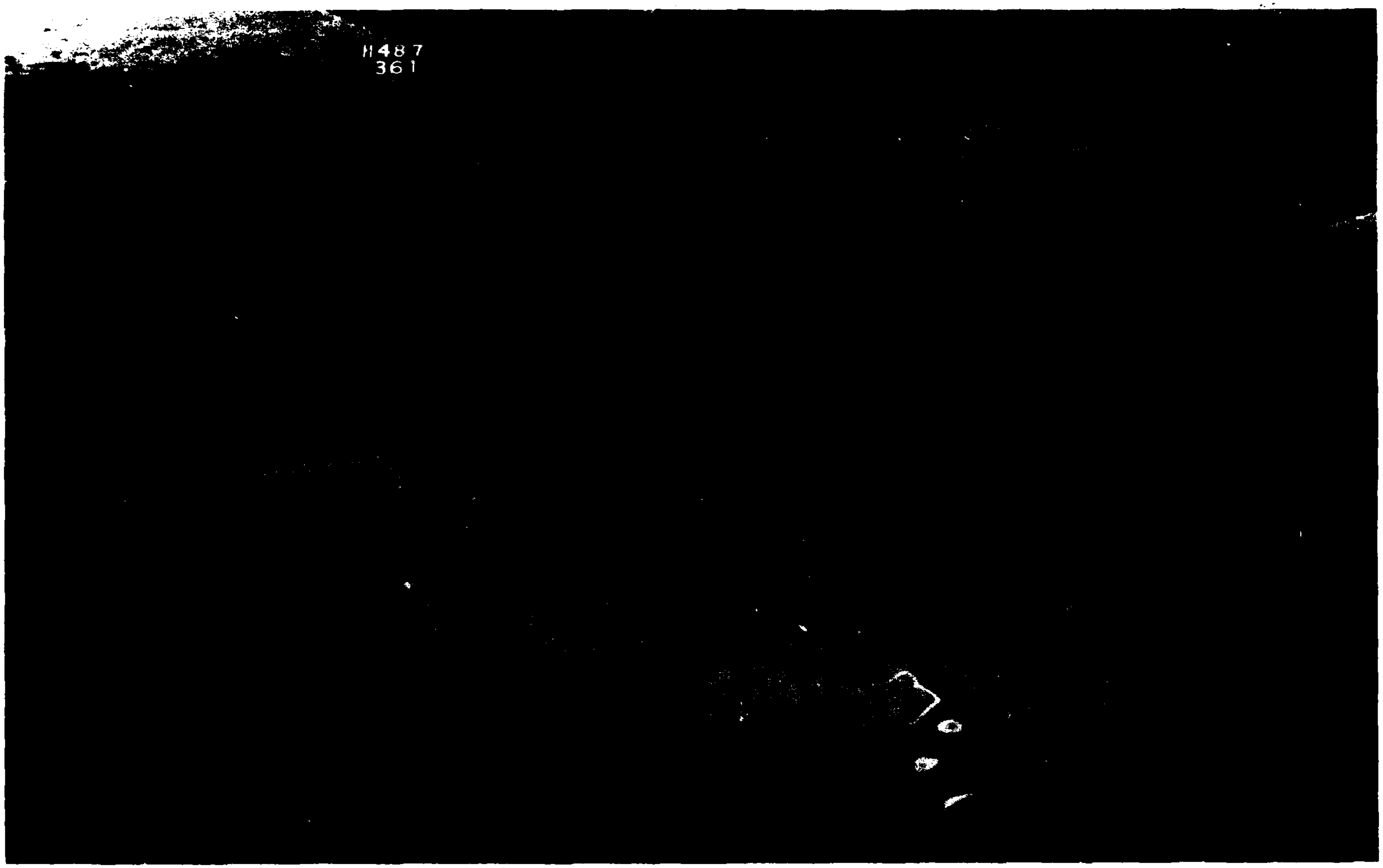


Photo 330. Typical wave patterns obtained for Plan 7J; 13-sec, 7-ft waves from SSW; swl = +6.7 ft

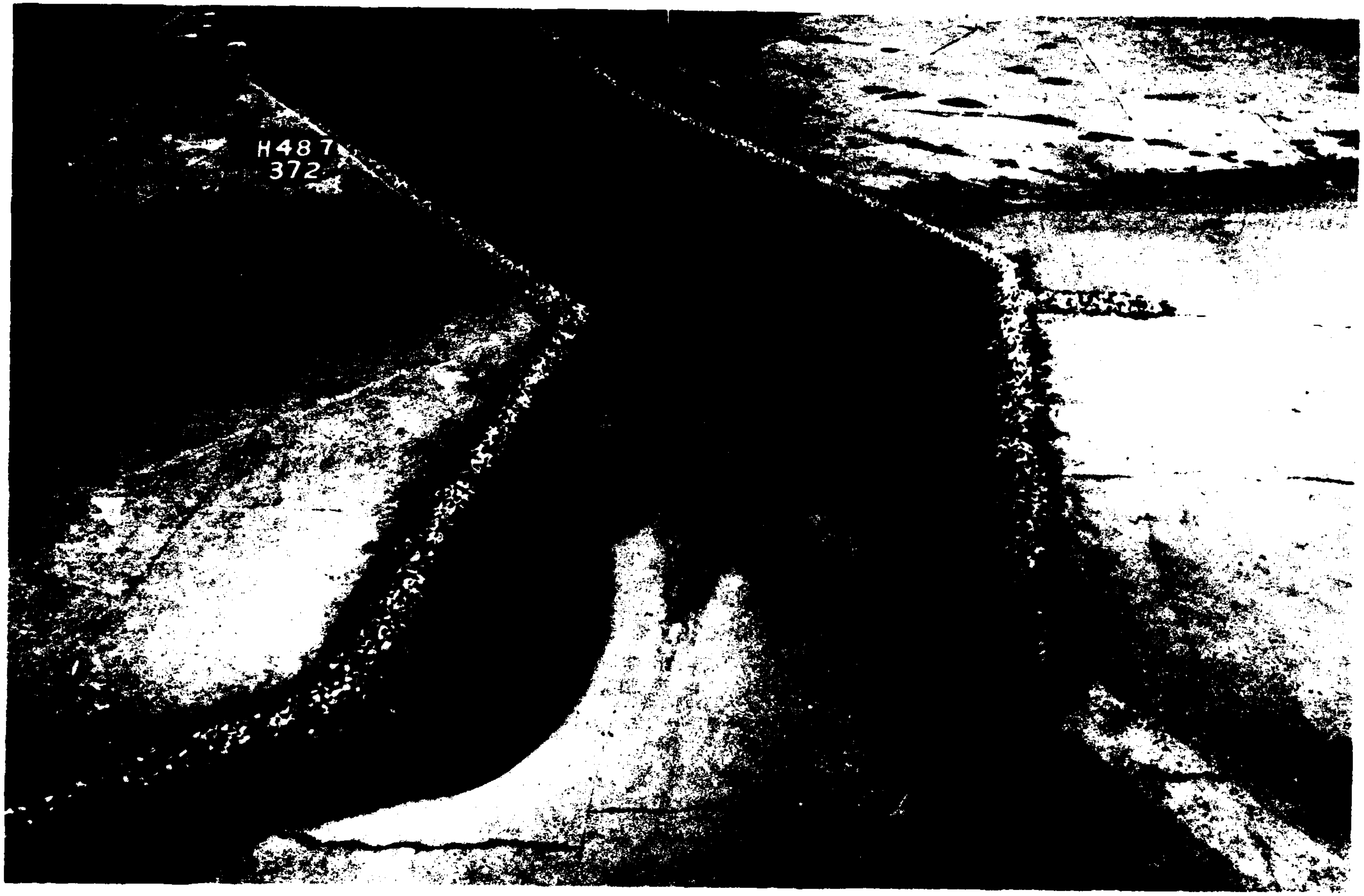


Photo 331. Shoal formed for Plan 7J; 11-sec, 12-ft waves from west

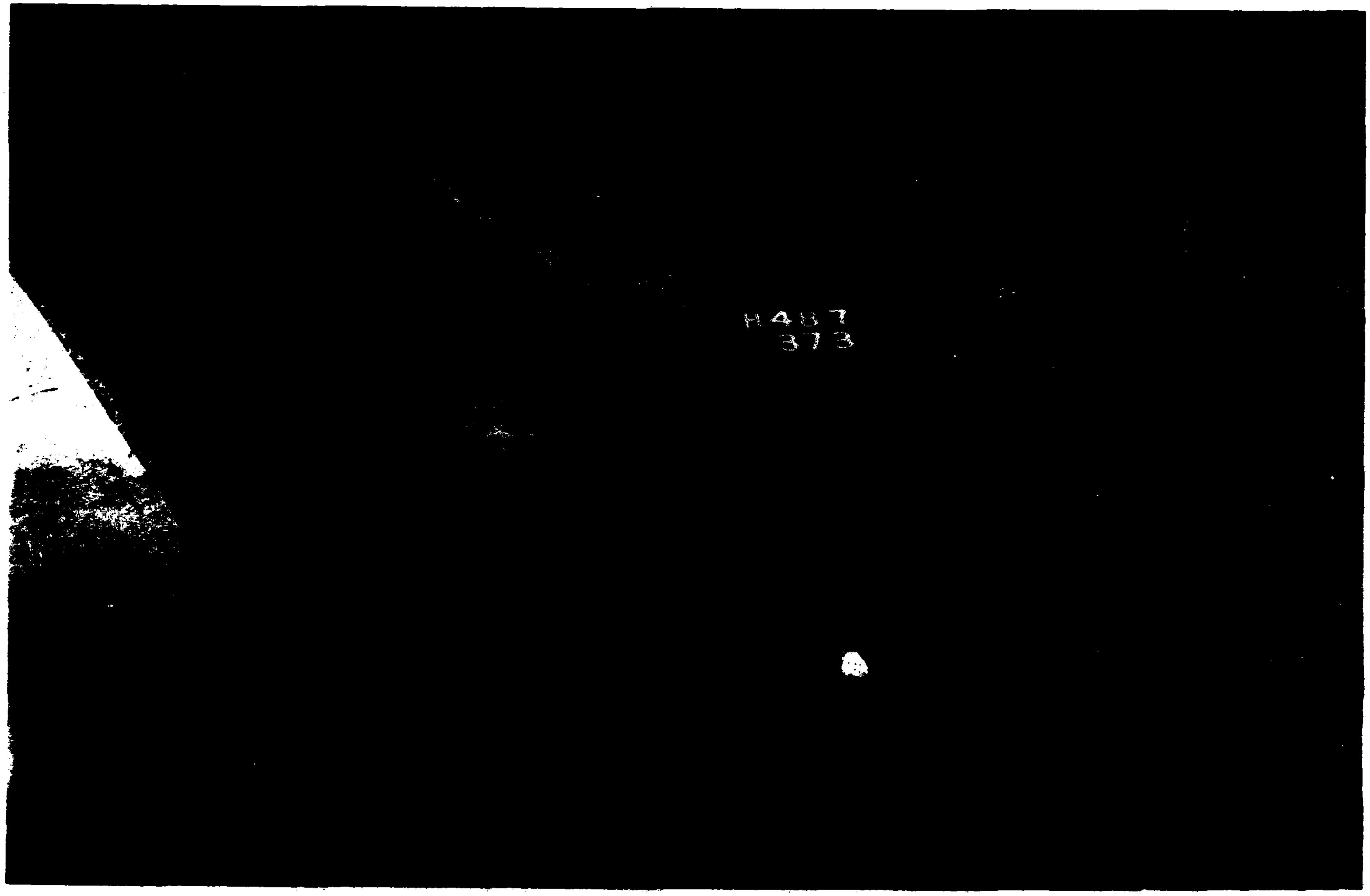


Photo 332. Closer view of shoal formed by 11-sec, 12-ft waves from west for Plan 7J

Photo 333. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 8; swl = +6.7 ft

Photo 334. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8; swl = +6.7 ft

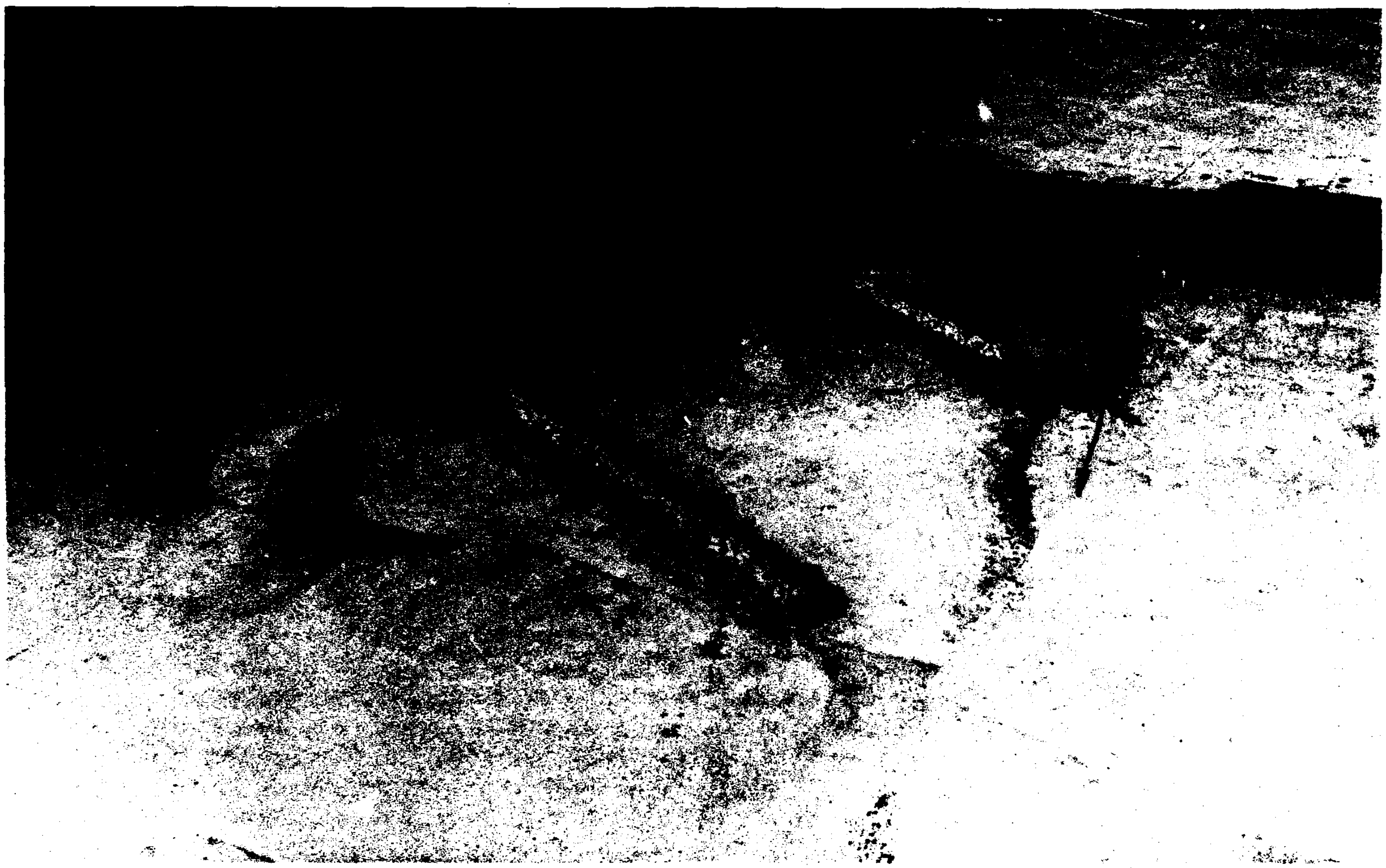


Photo 335. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8A; swl = +6.7 ft

Photo 336. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8B; swl = +6.7 ft

Photo 337. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8C; swl = +6.7 ft

Photo 338. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 8D; swl = +6.7 ft

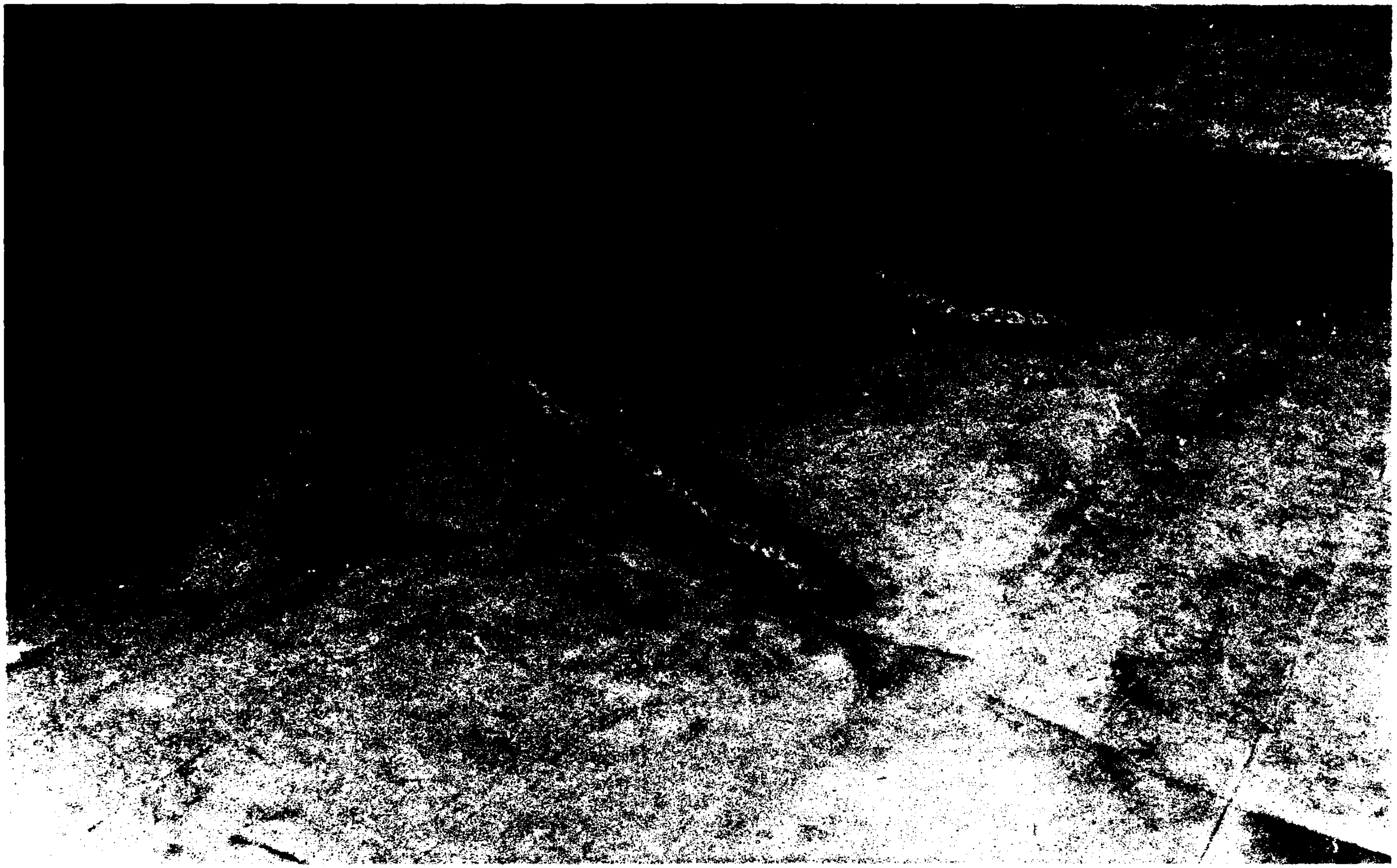


Photo 339. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8D; swl = +6.7 ft

Photo 340. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 8D; swl = +6.7 ft

Photo 341. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8D; swl = 0.0 ft

Photo 342. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 8D; swl = 0.0 ft

Photo 343. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 8D; swl = 0.0 ft

Photo 344. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 8D; swl = 0.0 ft

Photo 345. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 8D; swl = 0.0 ft

Photo 346. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 9; swl = 0.0 ft

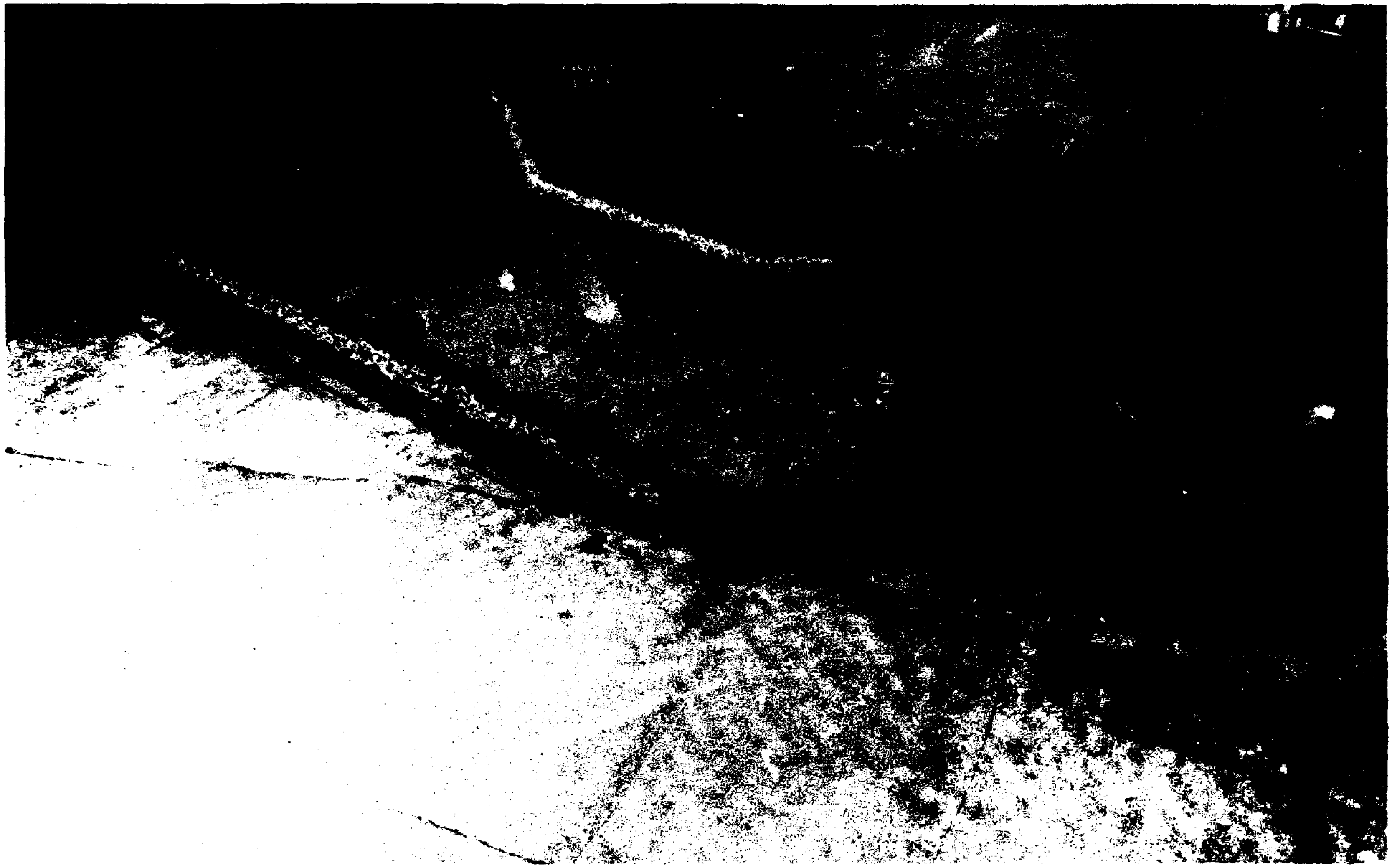


Photo 347. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 8D; swl = 0.0 ft

Photo 348. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 8D; swl = 0.0 ft

Photo 349. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 8D; swl = 0.0 ft

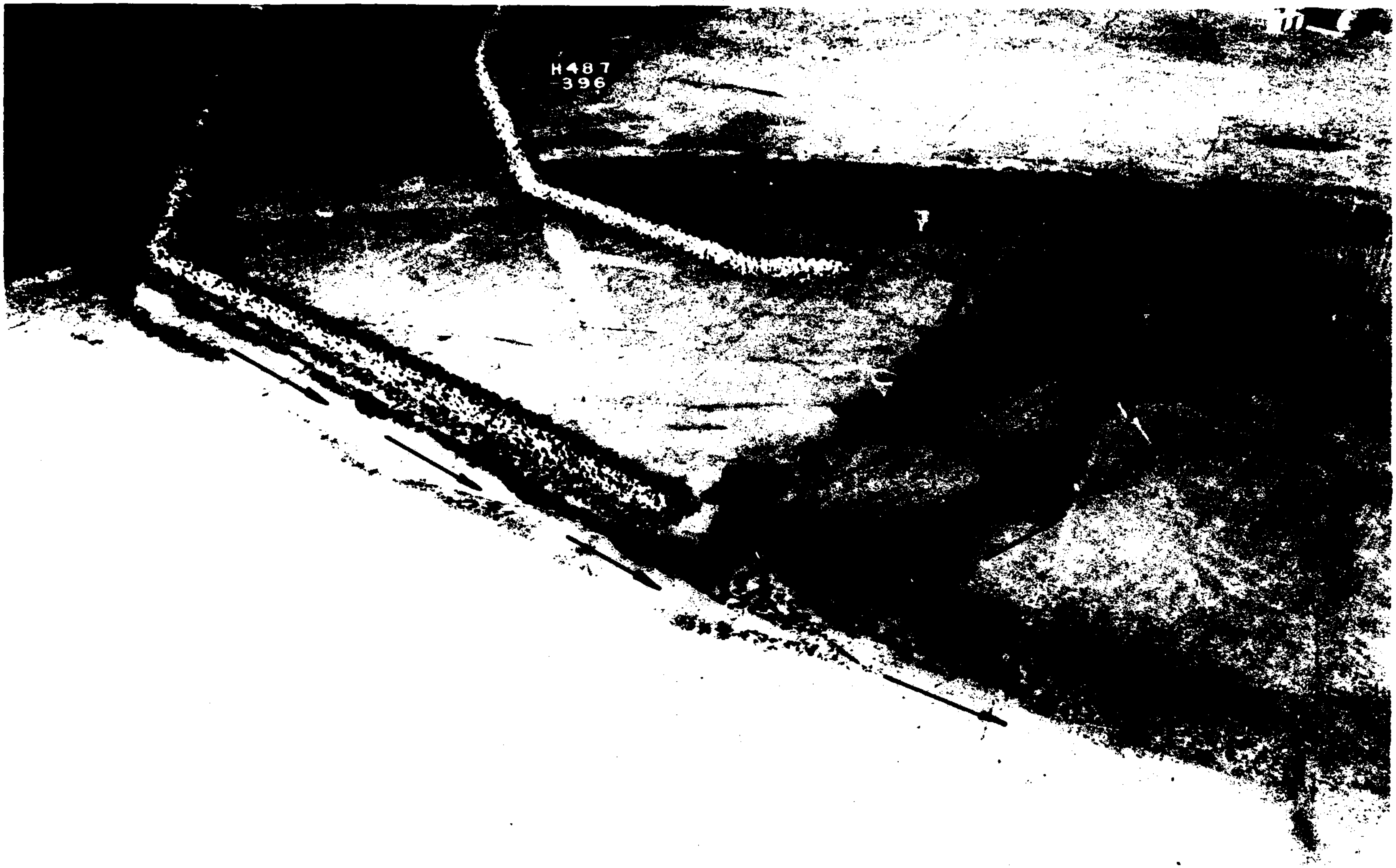


Photo 350. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum ebb for Plan 8D; swl = +1.5 ft

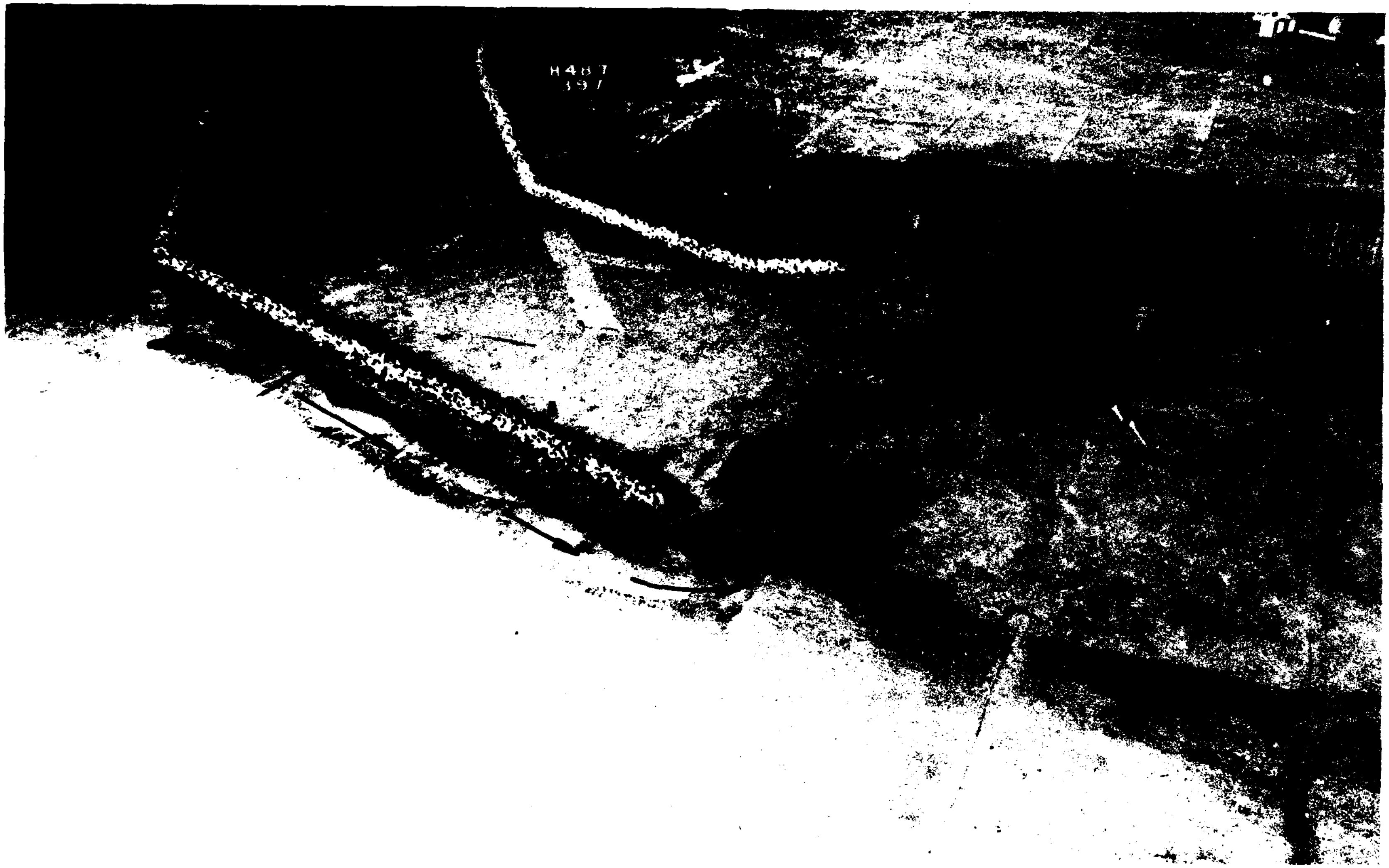


Photo 351. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for maximum flood for Plan 8D; swl = +4.3 ft

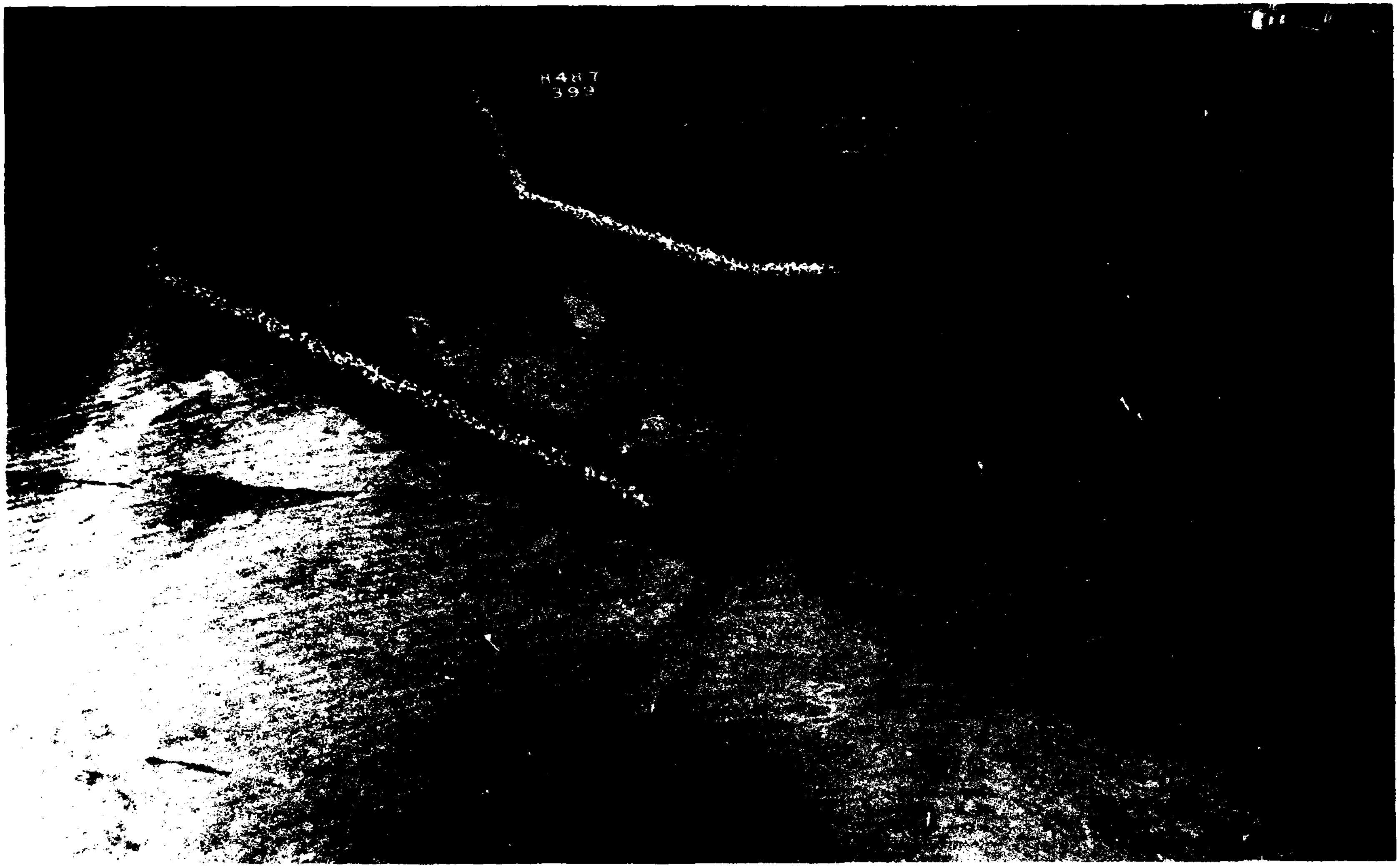


Photo 352. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 8D; swl = +6.7 ft

Photo 353. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 8D; swl = +6.7 ft

Photo 354. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 8D; swl = +6.7 ft

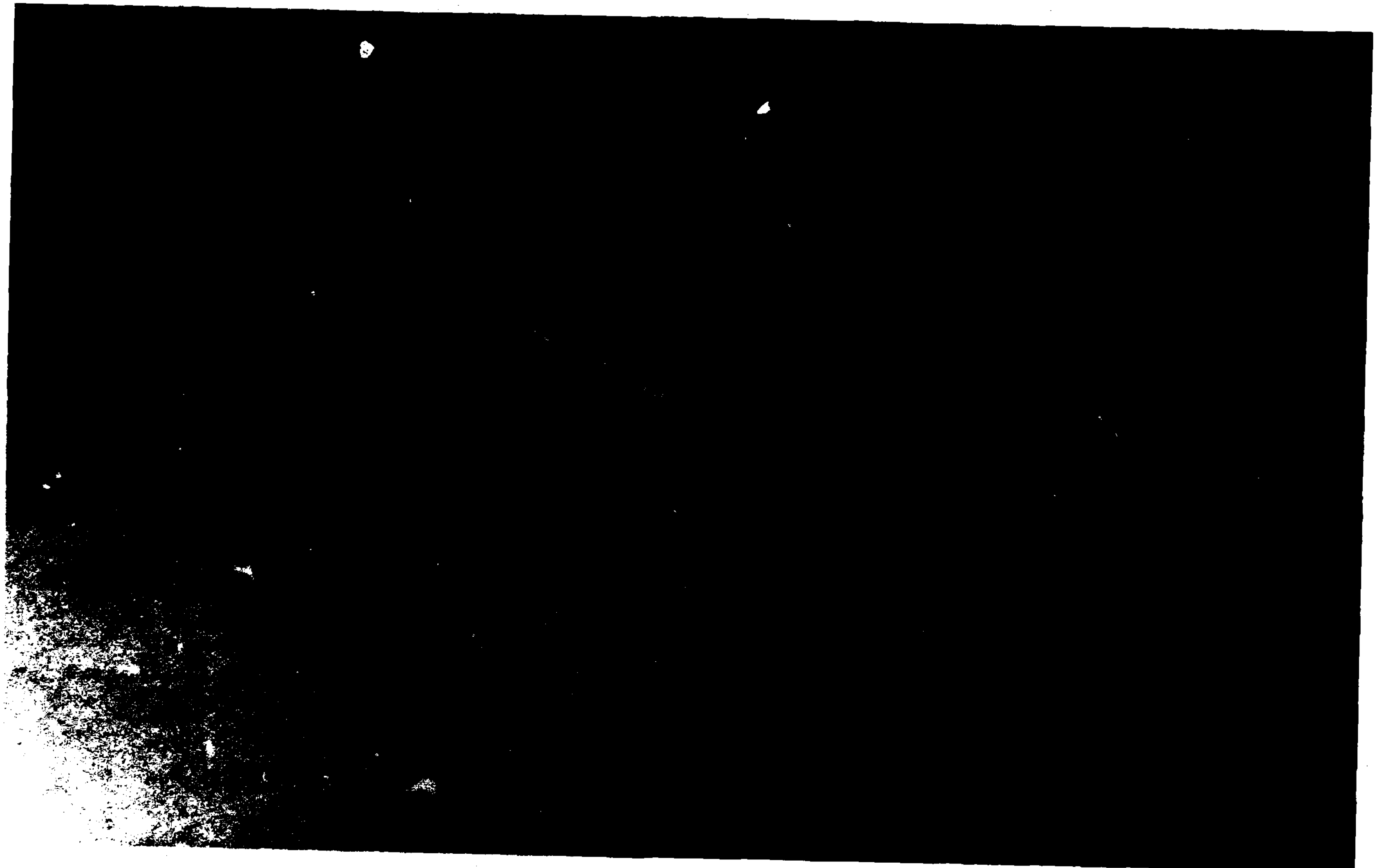


Photo 355. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for Plan 8D; swl = 0.0 ft

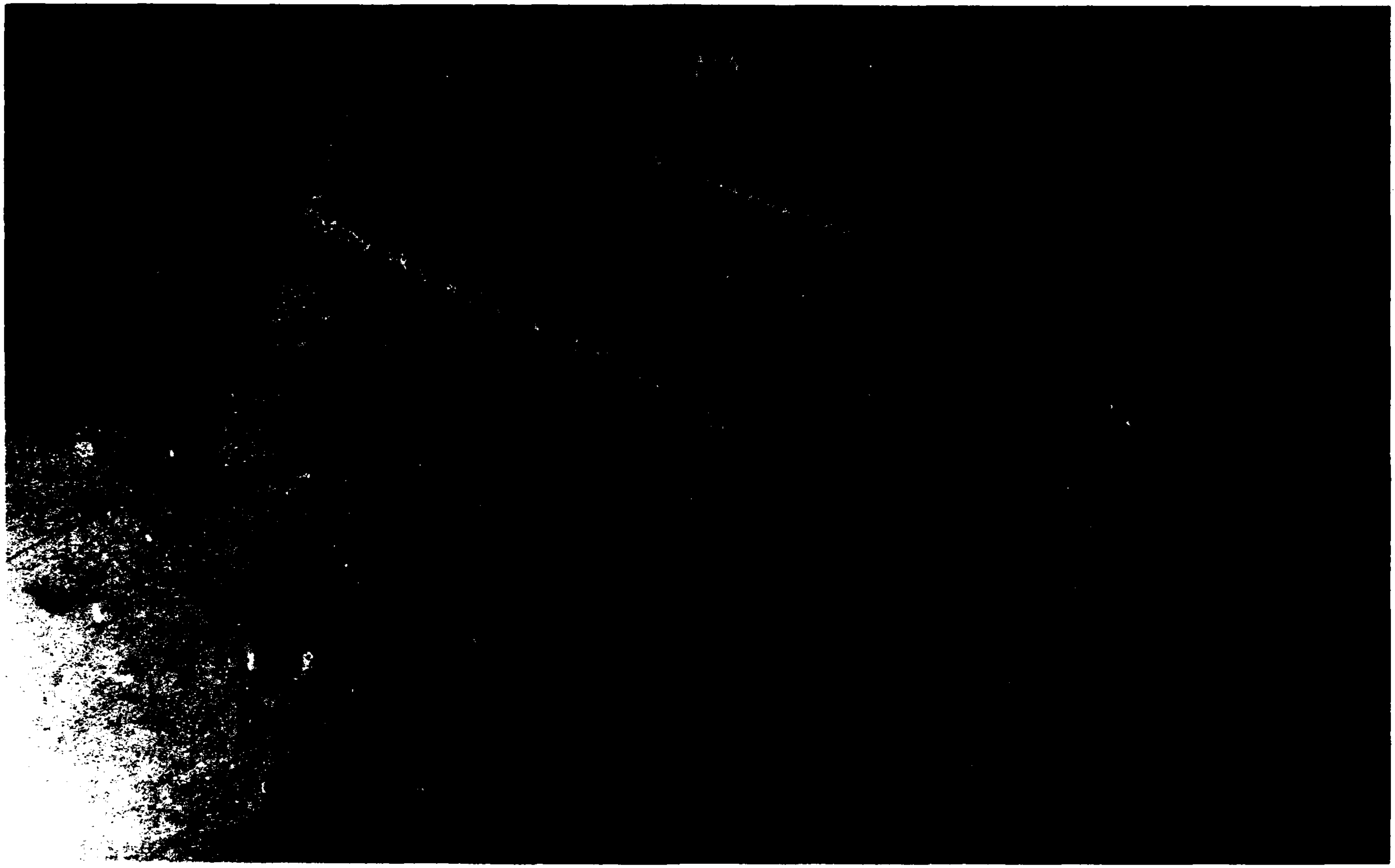


Photo 356. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum ebb for Plan 8D; swl = +1.5 ft

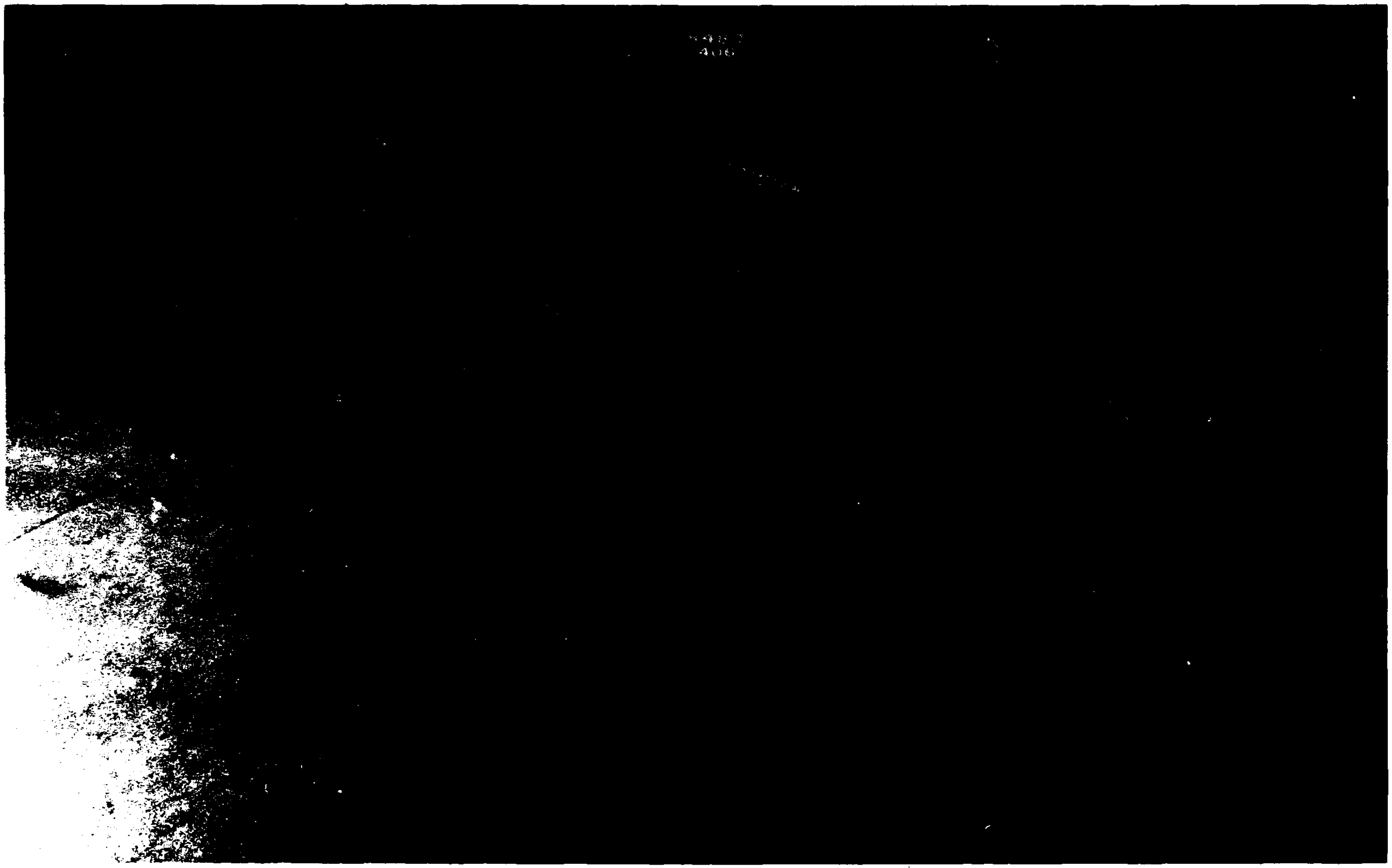


Photo 357. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for maximum flood for Plan 8D; swl = 4.3 ft

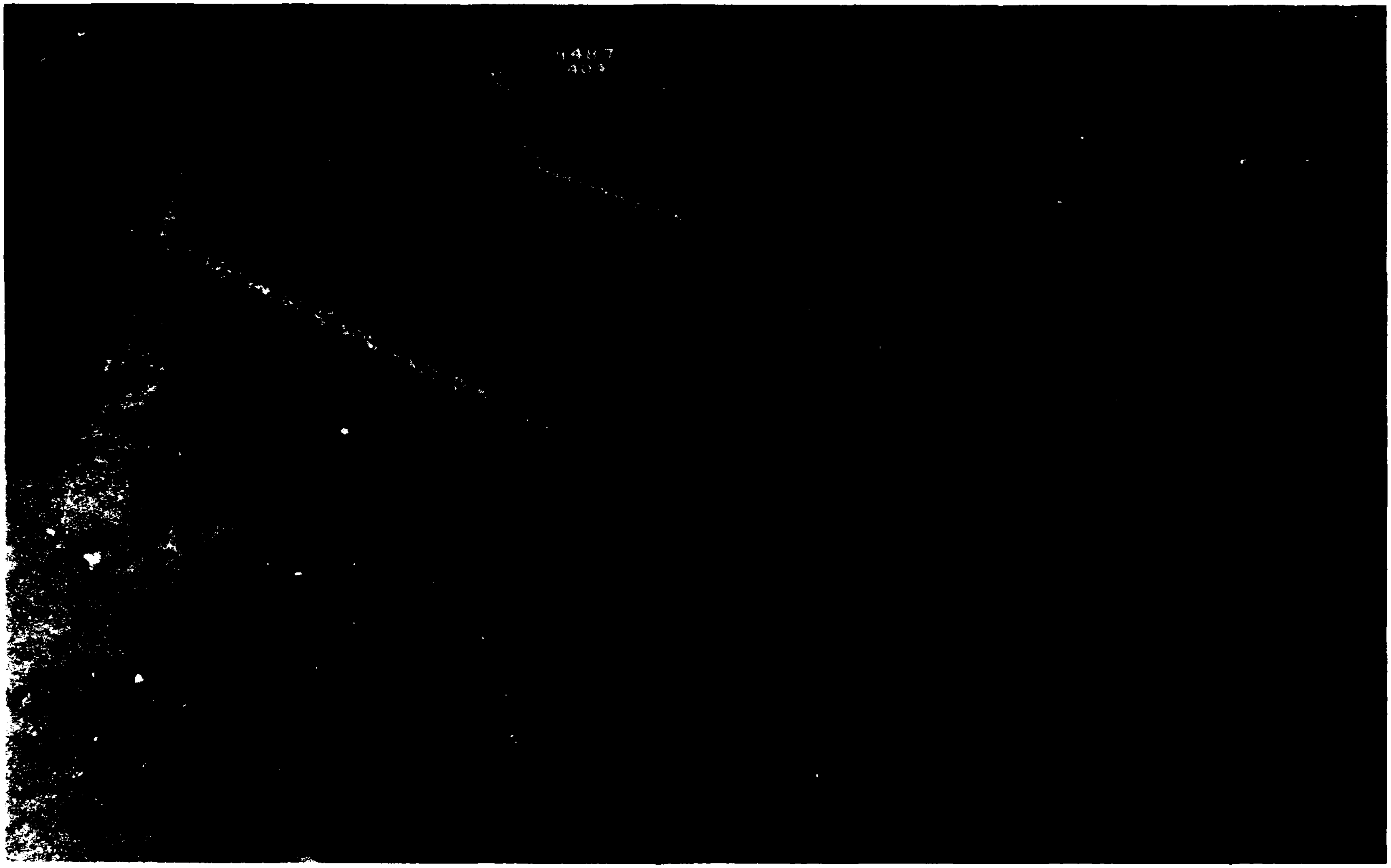


Photo 358. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for Plan 8D; swl = +6.7 ft

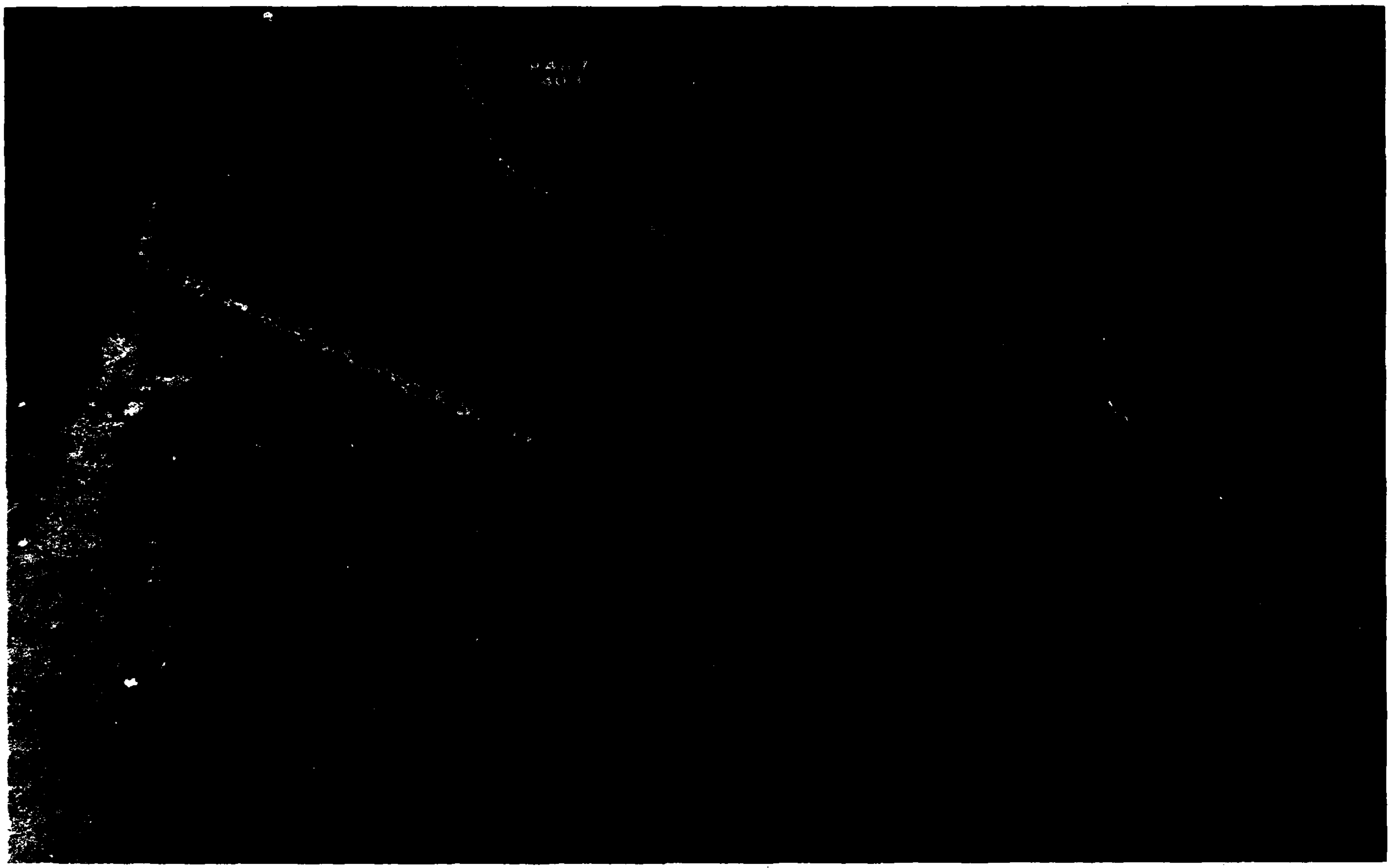


Photo 359. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for Plan 8D; swl = +6.7 ft

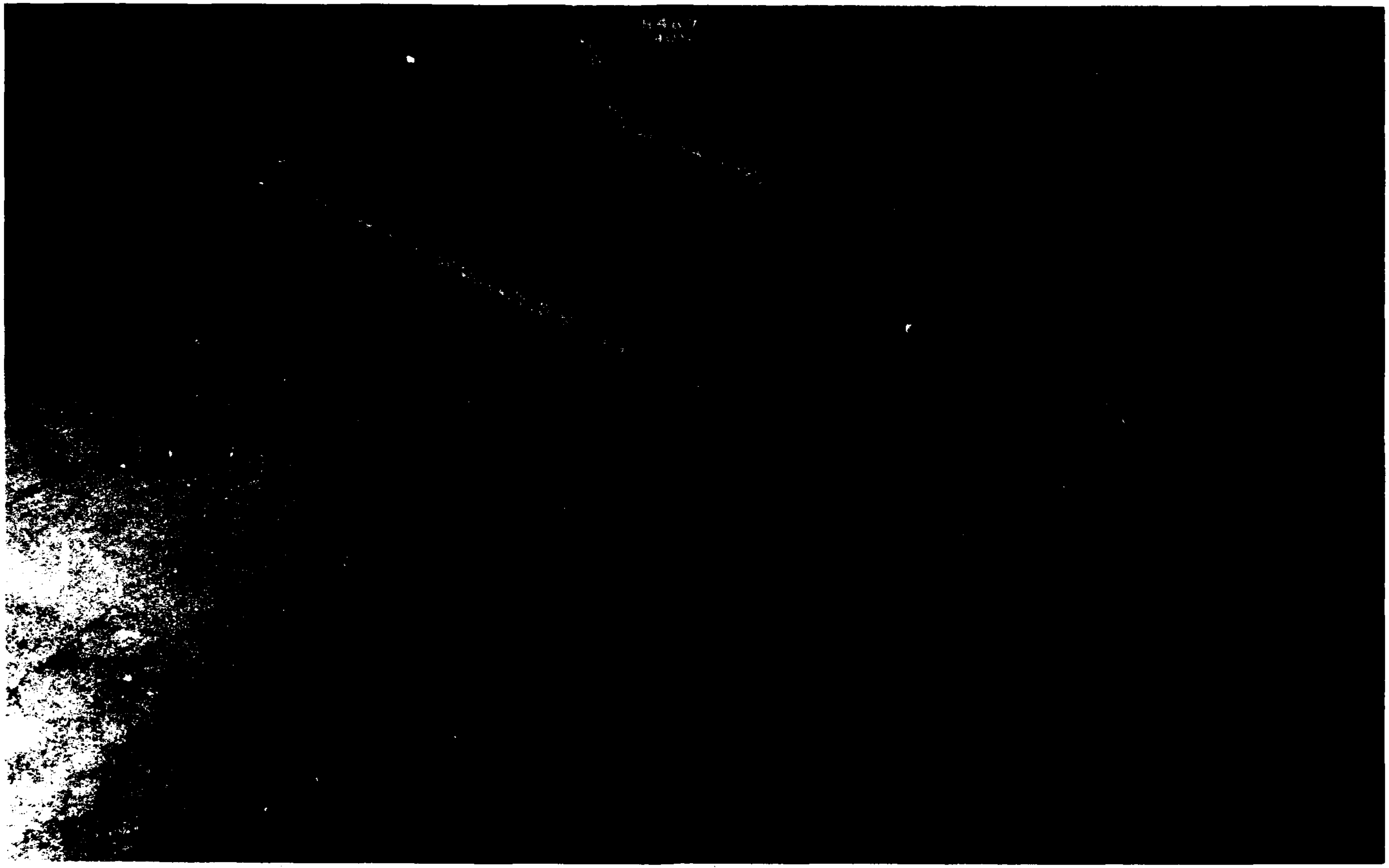


Photo 360. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for Plan 8D; swl = +6.7 ft

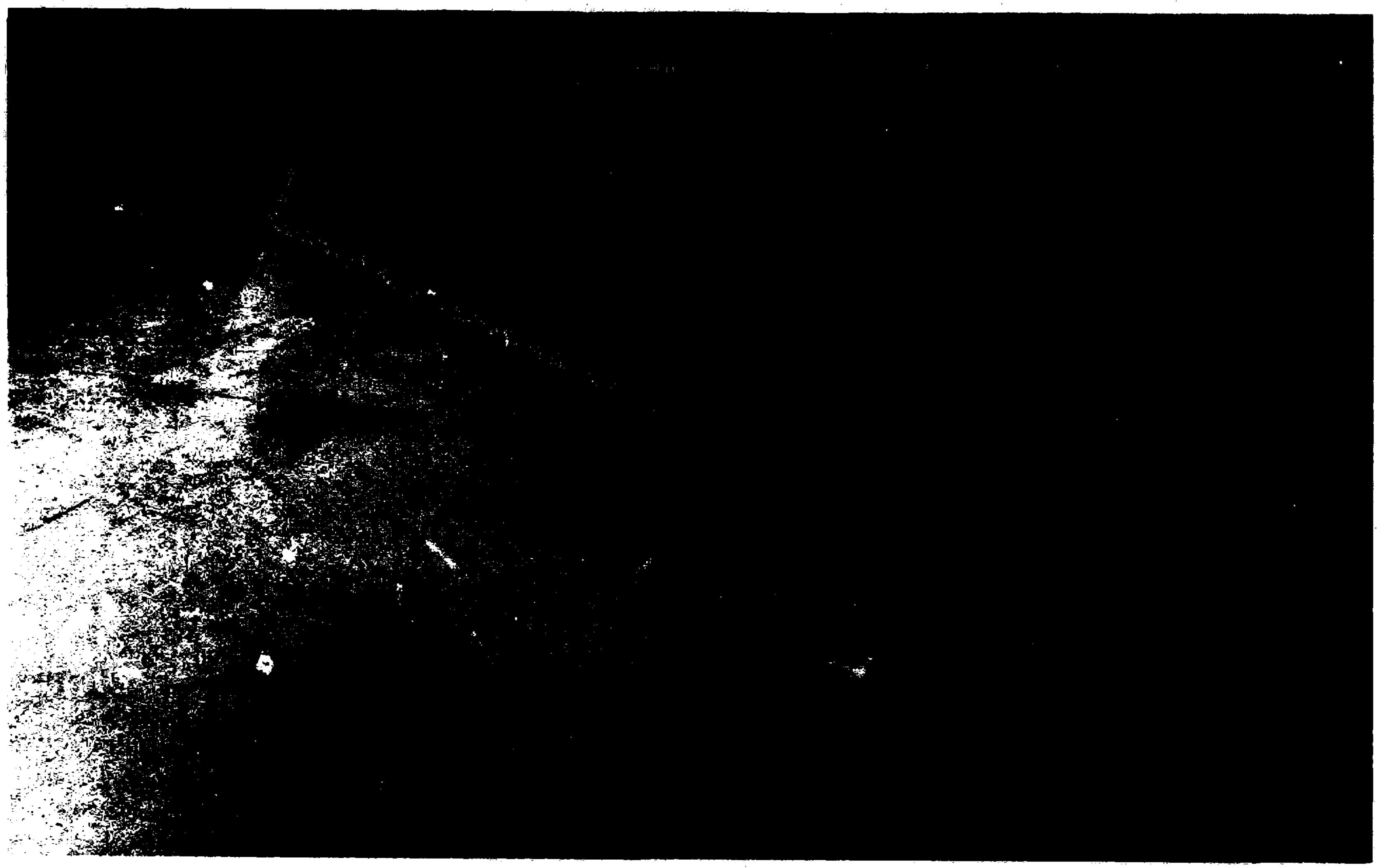


Photo 361. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for Plan 8D; swl = 0.0 ft

Photo 362. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum ebb for Plan 8D; swl = +1.5 ft

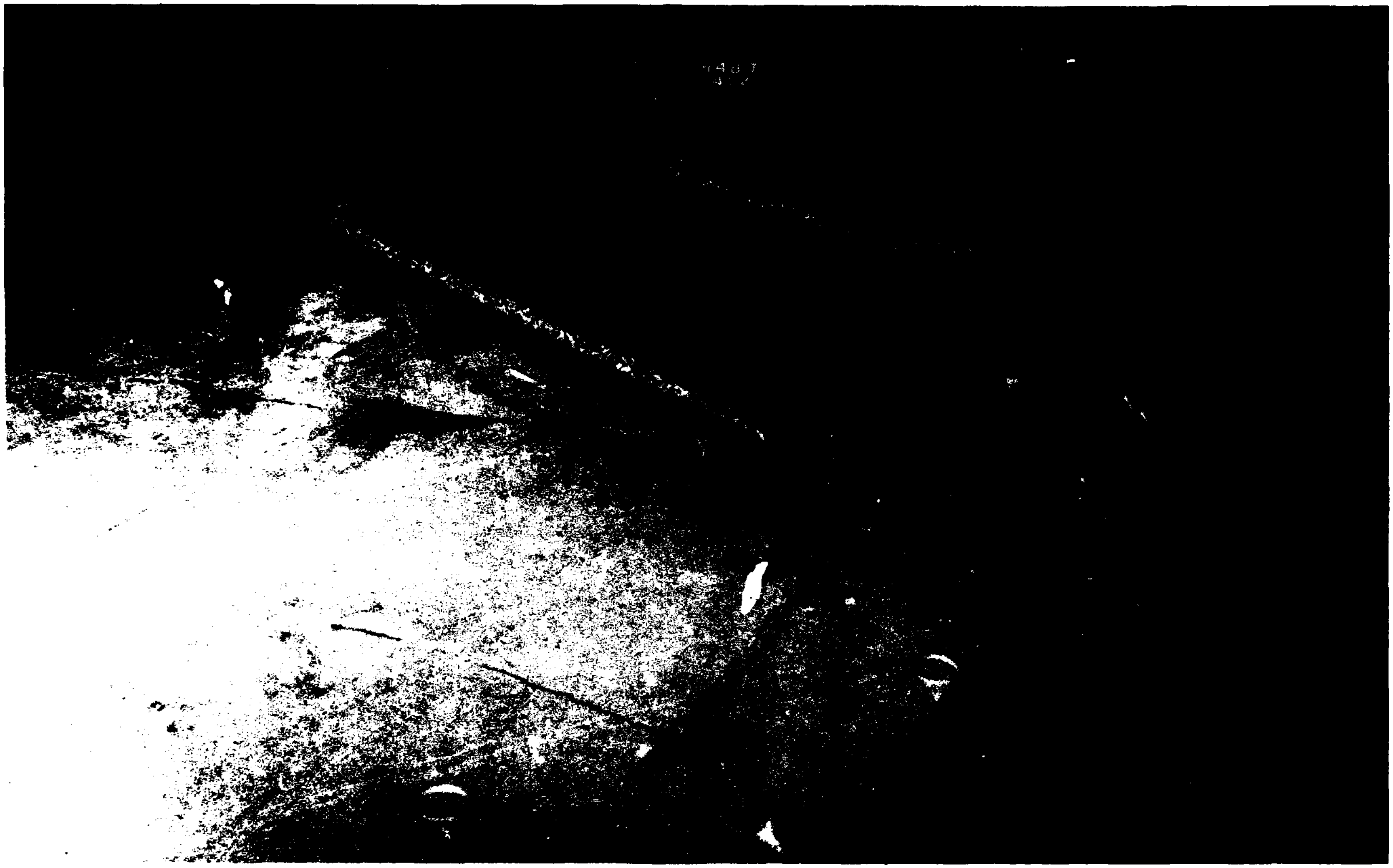


Photo 363. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for maximum flood for Plan 8D; swl = +4.3 ft

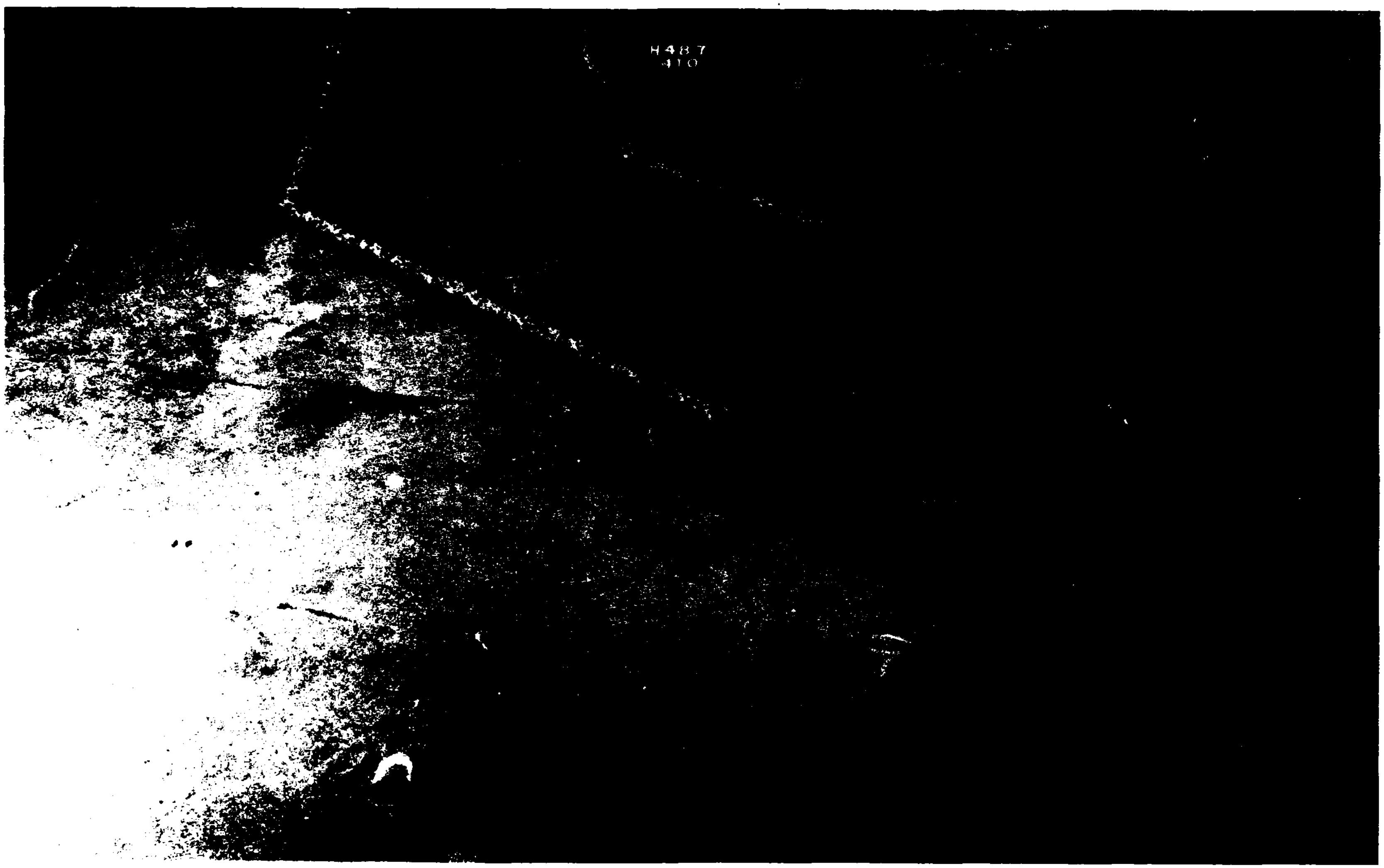


Photo 364. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for Plan 8D; swl = +6.7 ft

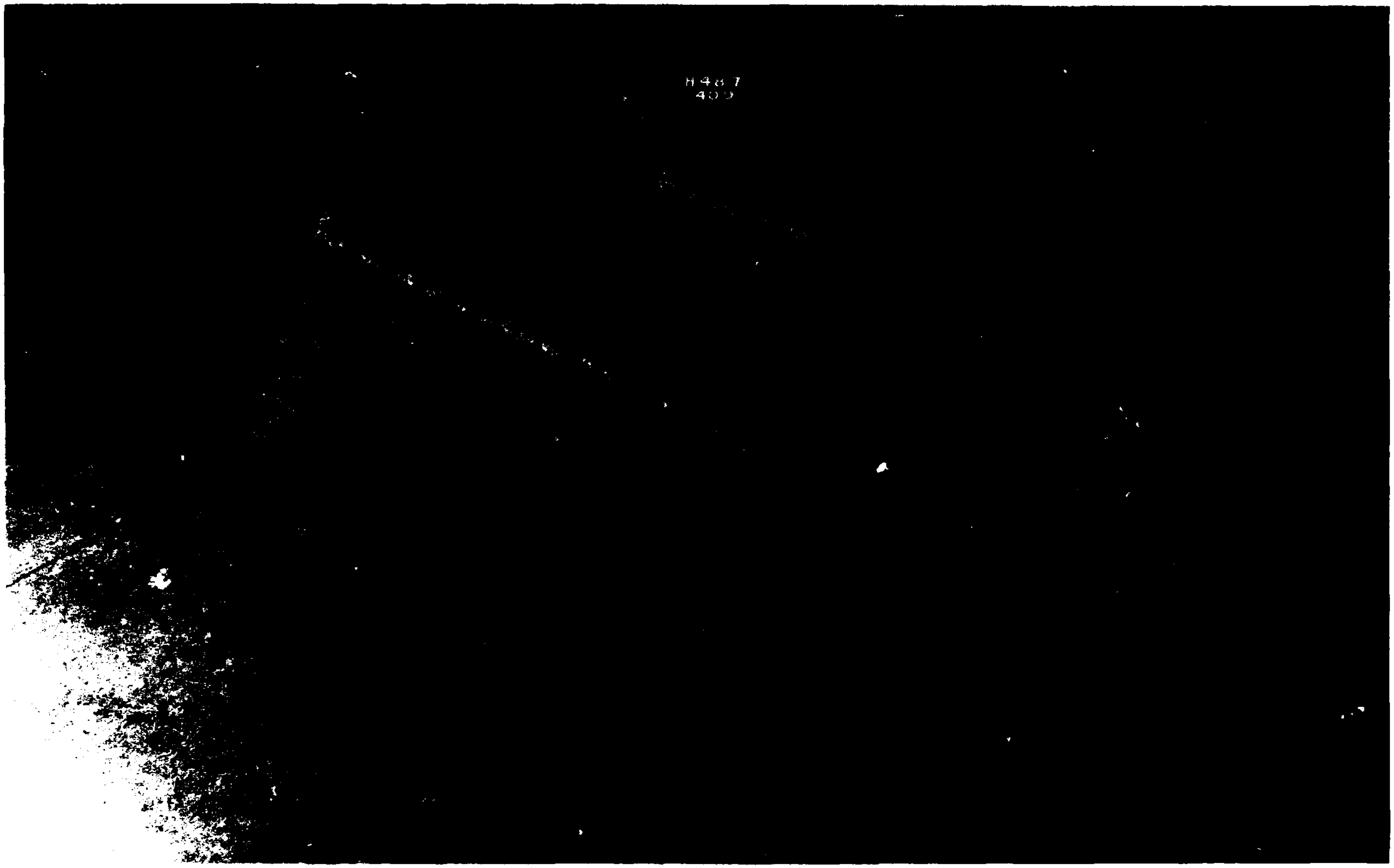
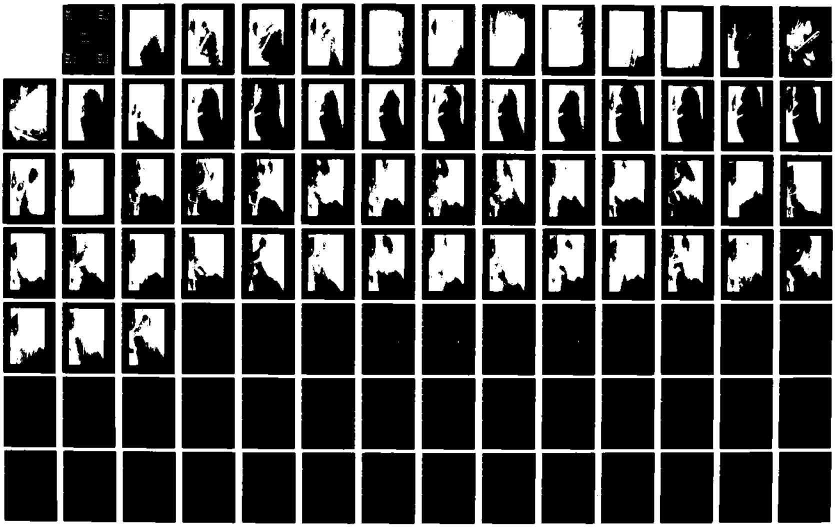
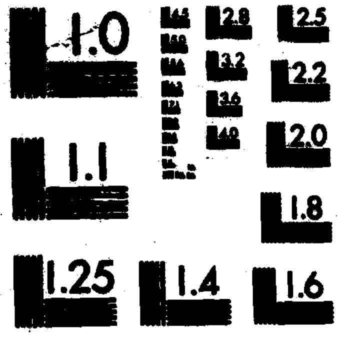


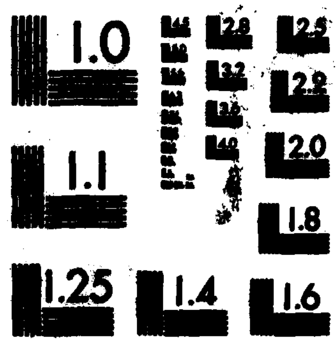
Photo 365. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for Plan 8D; swl = +6.7 ft

AD-A120 826 DESIGN FOR FLOOD CONTROL WAVE PROTECTION AND PREVENTION 6/7
OF SHOALING ROGUE..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
UNCLASSIFIED AUG 82 WES/TR/HL-82-18 F/G 13/2 NL

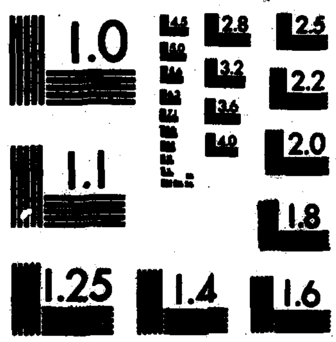




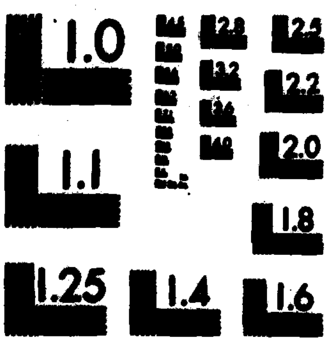
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



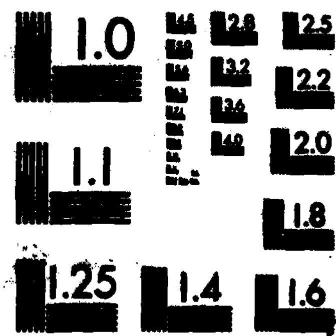
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Photo 366. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for Plan 8D; swl = +6.7 ft

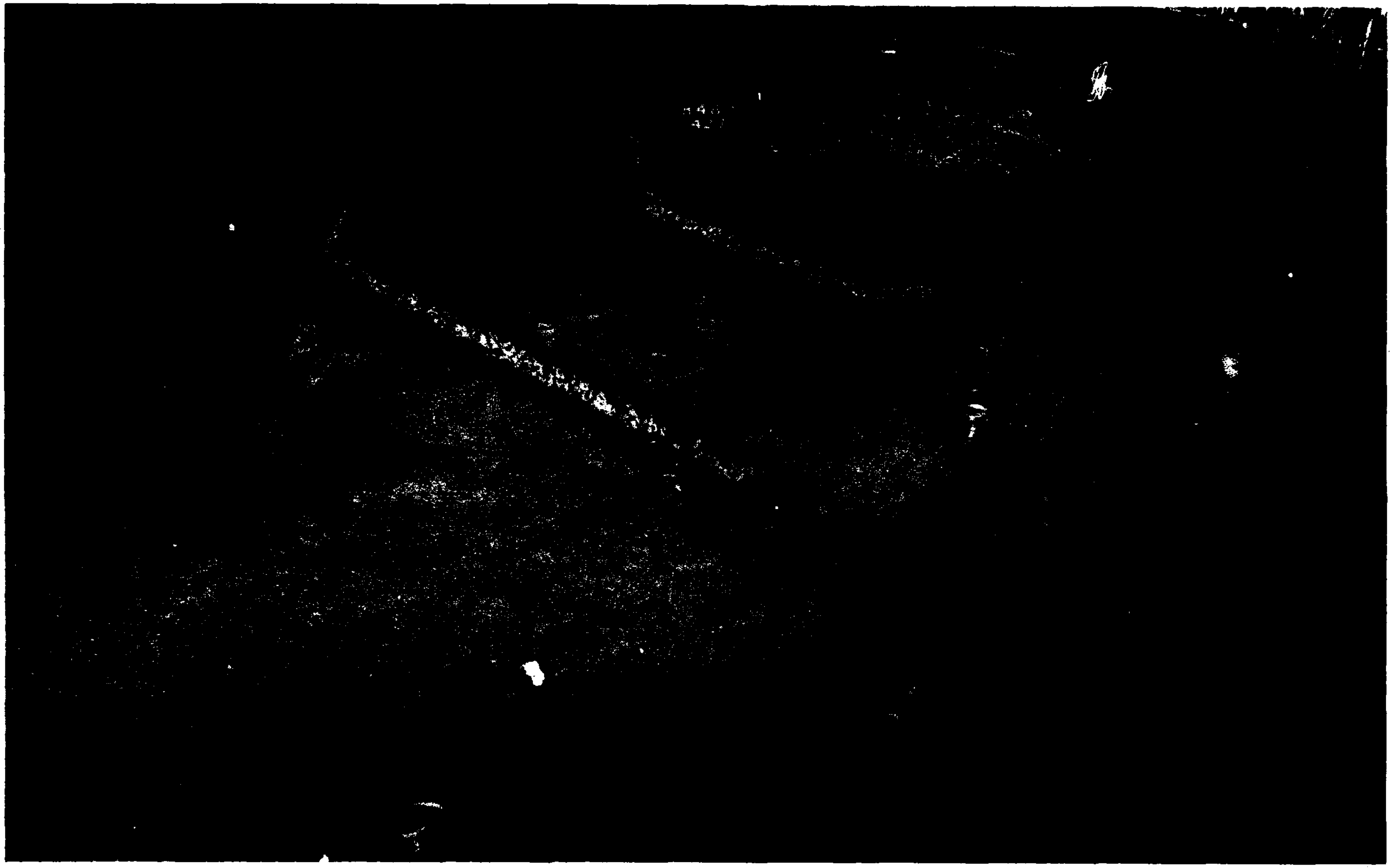


Photo 367. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8D; swl = 0.0 ft

Photo 36ä General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum ebb for Plan 8D; swl = +1.5 ft

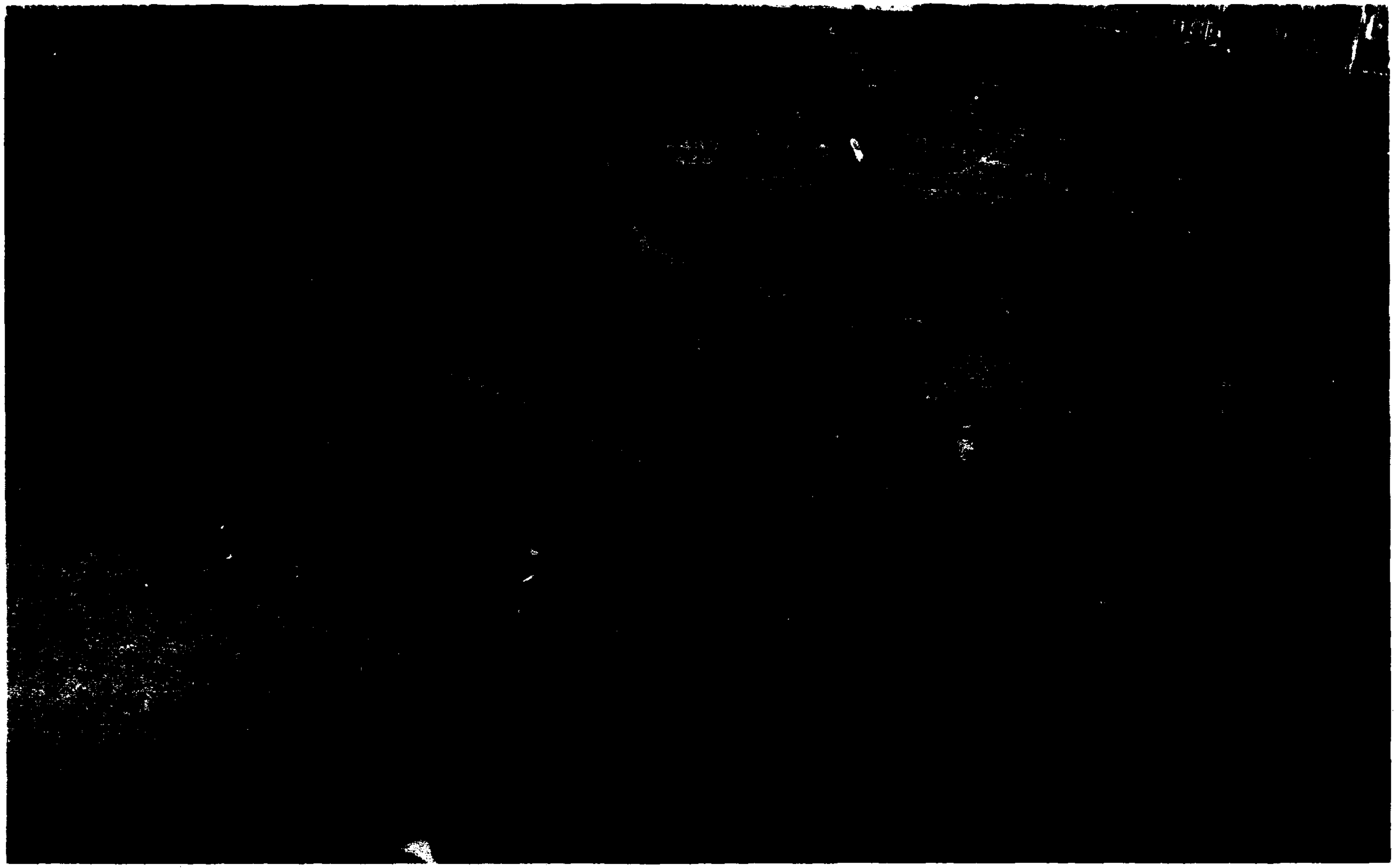


Photo 369. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for maximum flood for Plan 8D; swl = +4.3 ft

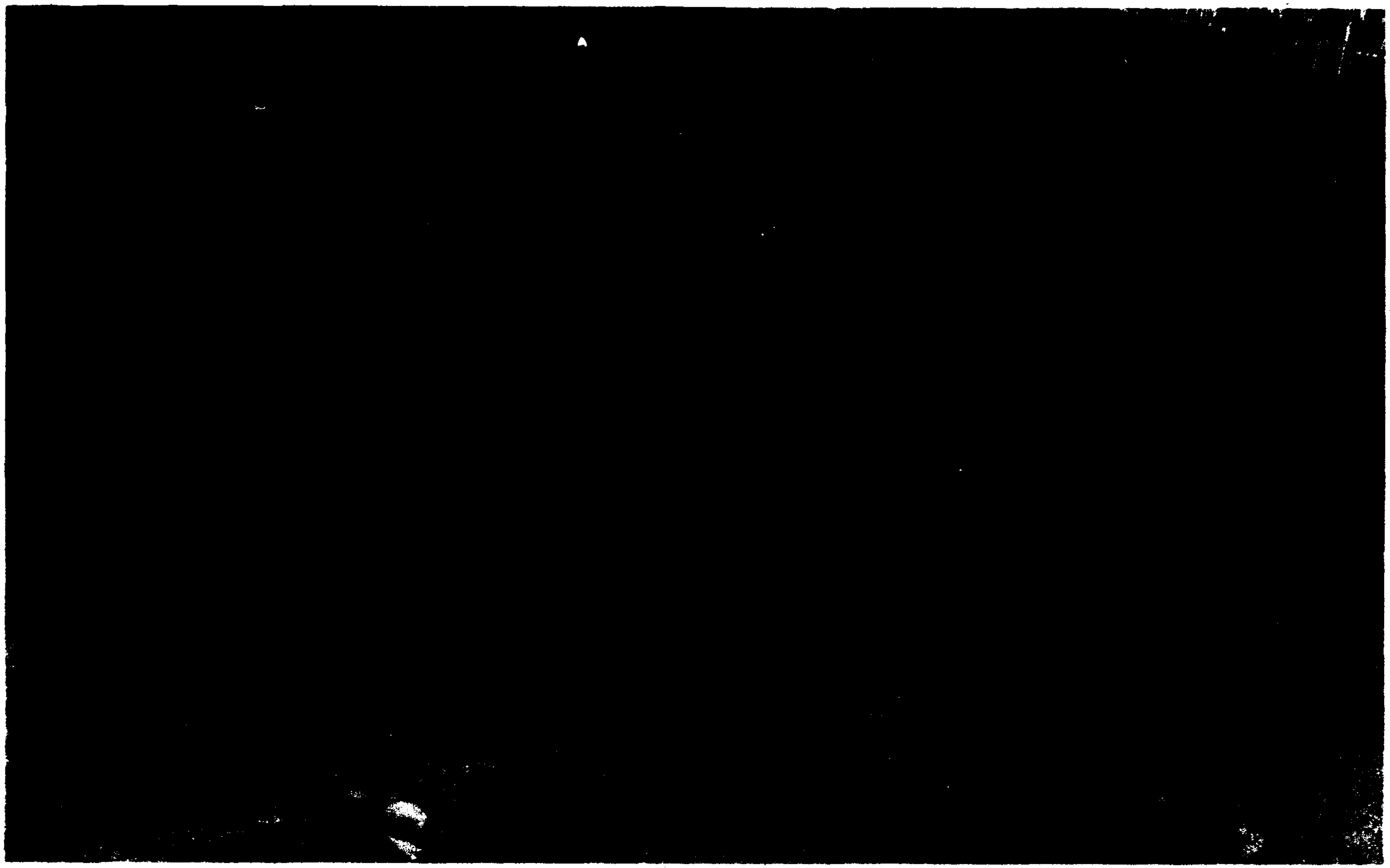


Photo 370. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 8D; swl = +6.7 ft

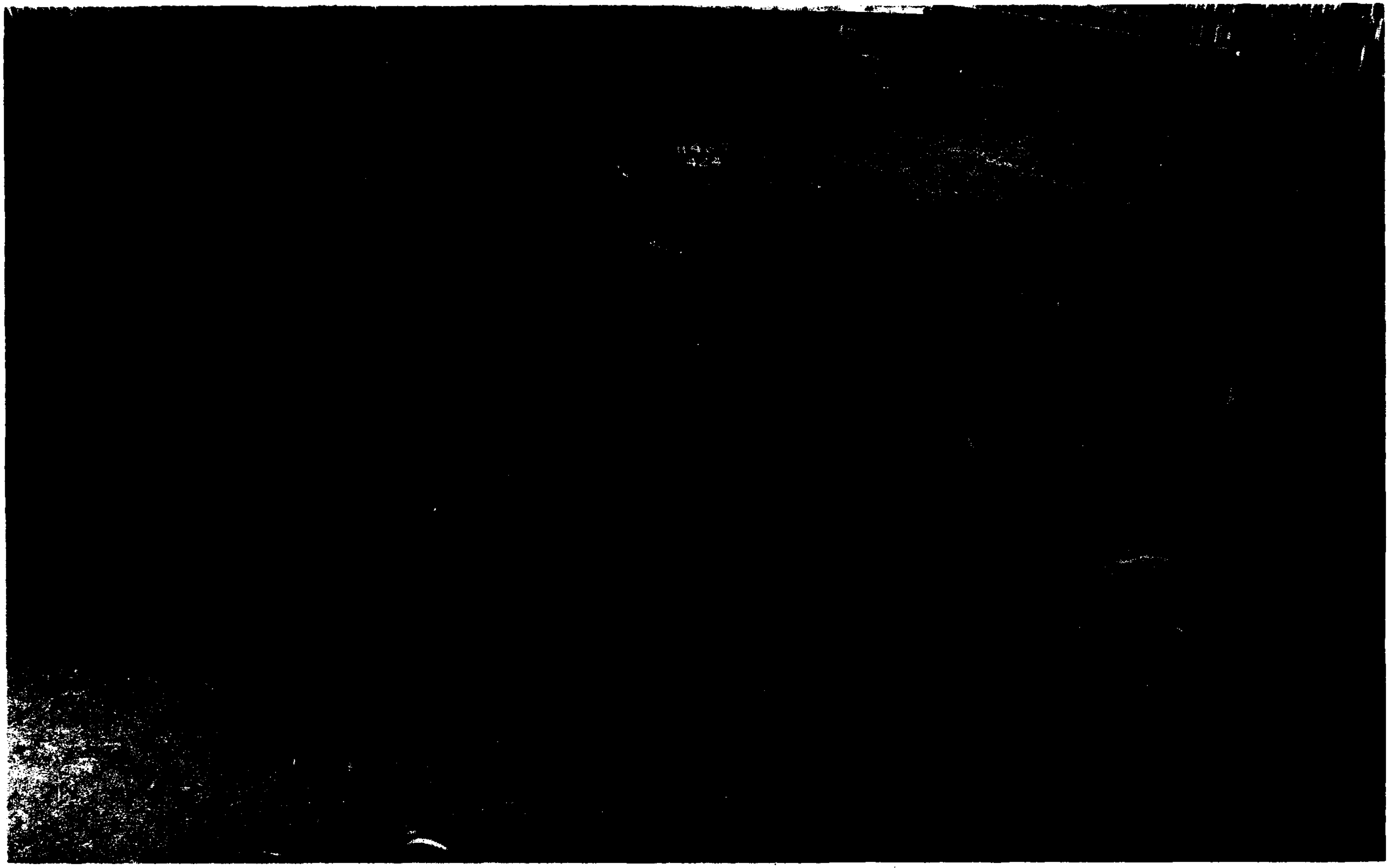


Photo 371. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 8D; swl = +6.7 ft

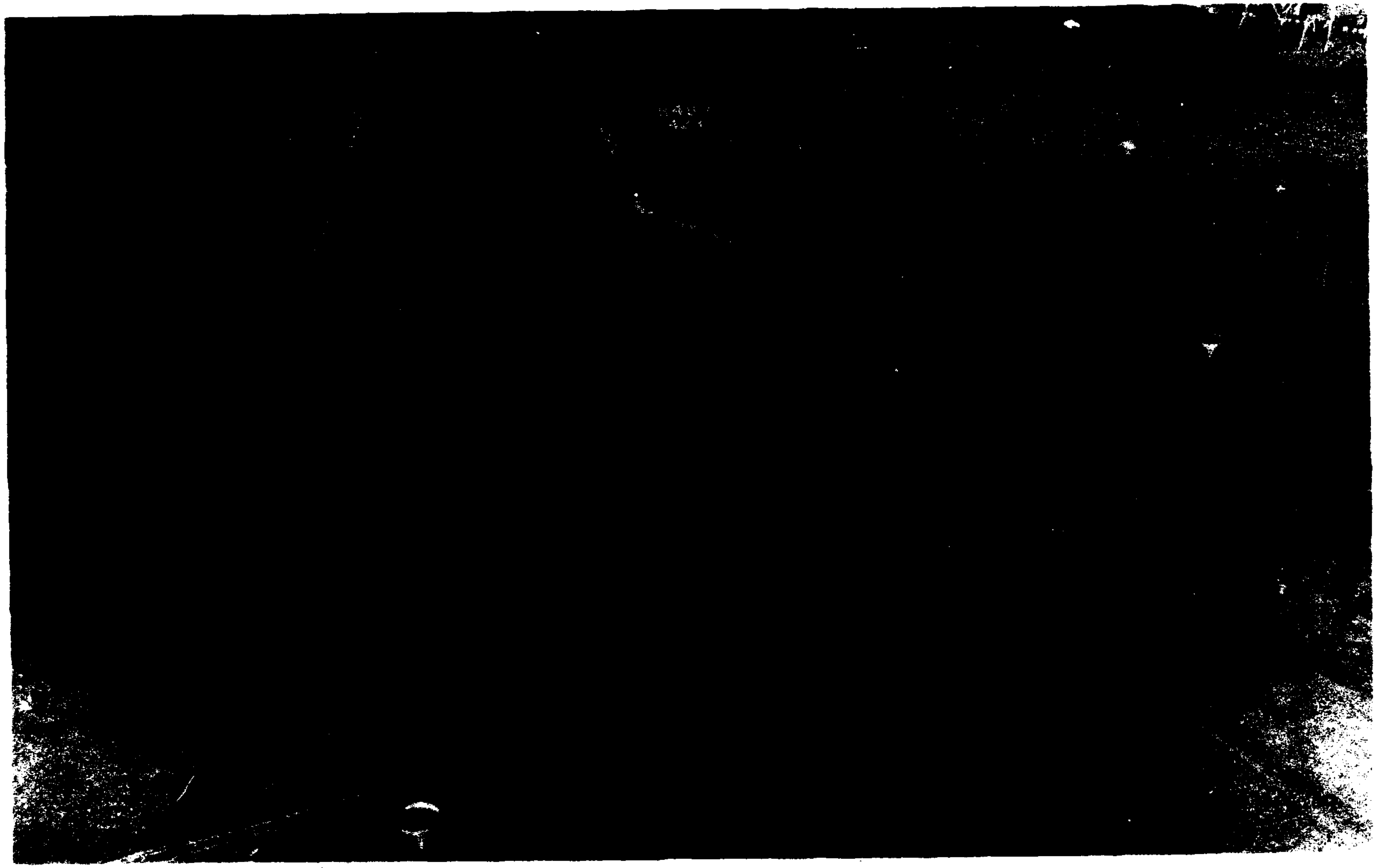


Photo 372. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 8D; swl = +6.7 ft

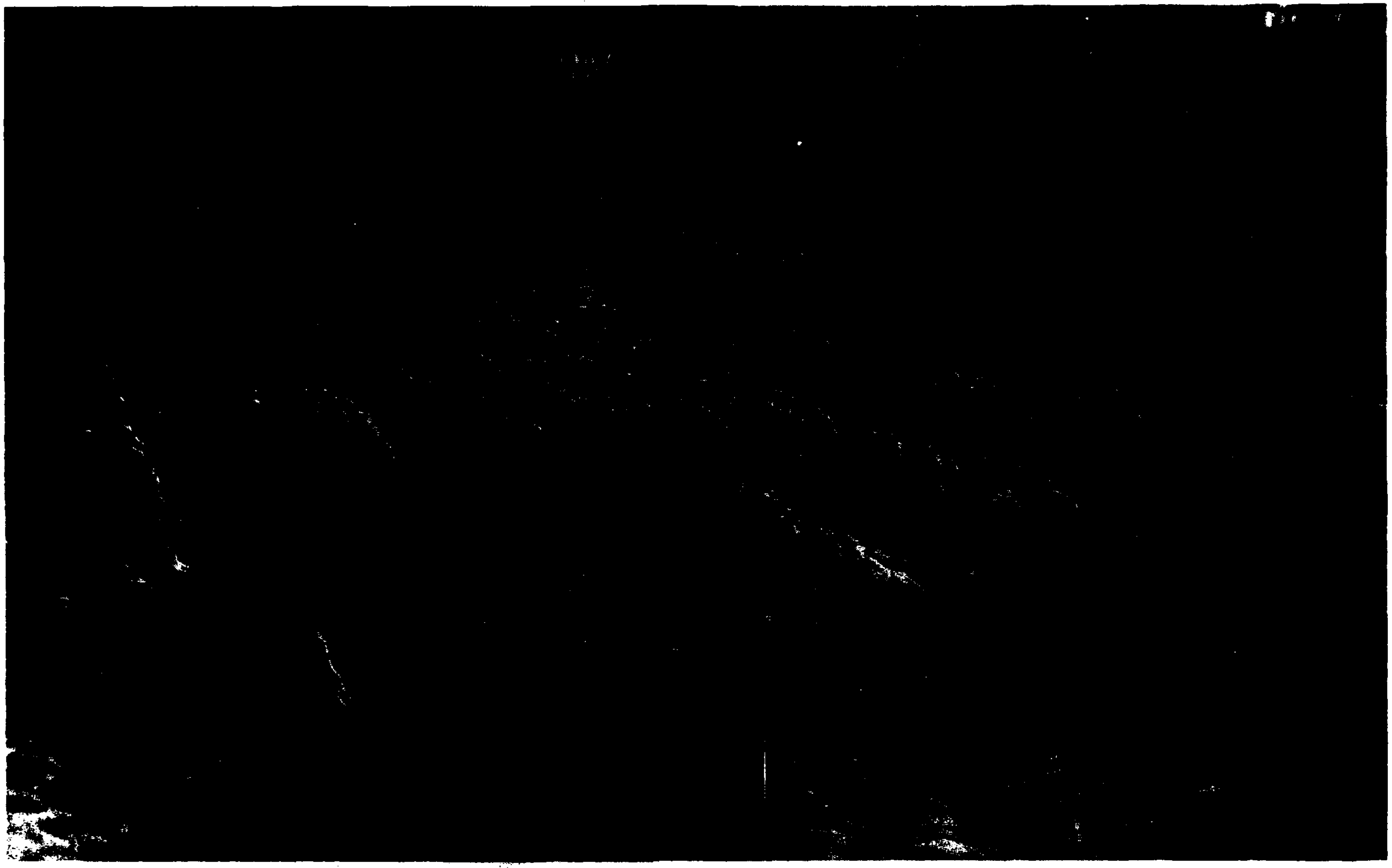


Photo 373. Typical wave patterns obtained for Plan 8D; 11-sec, 12-ft waves from NNW; swl = +6.7 ft

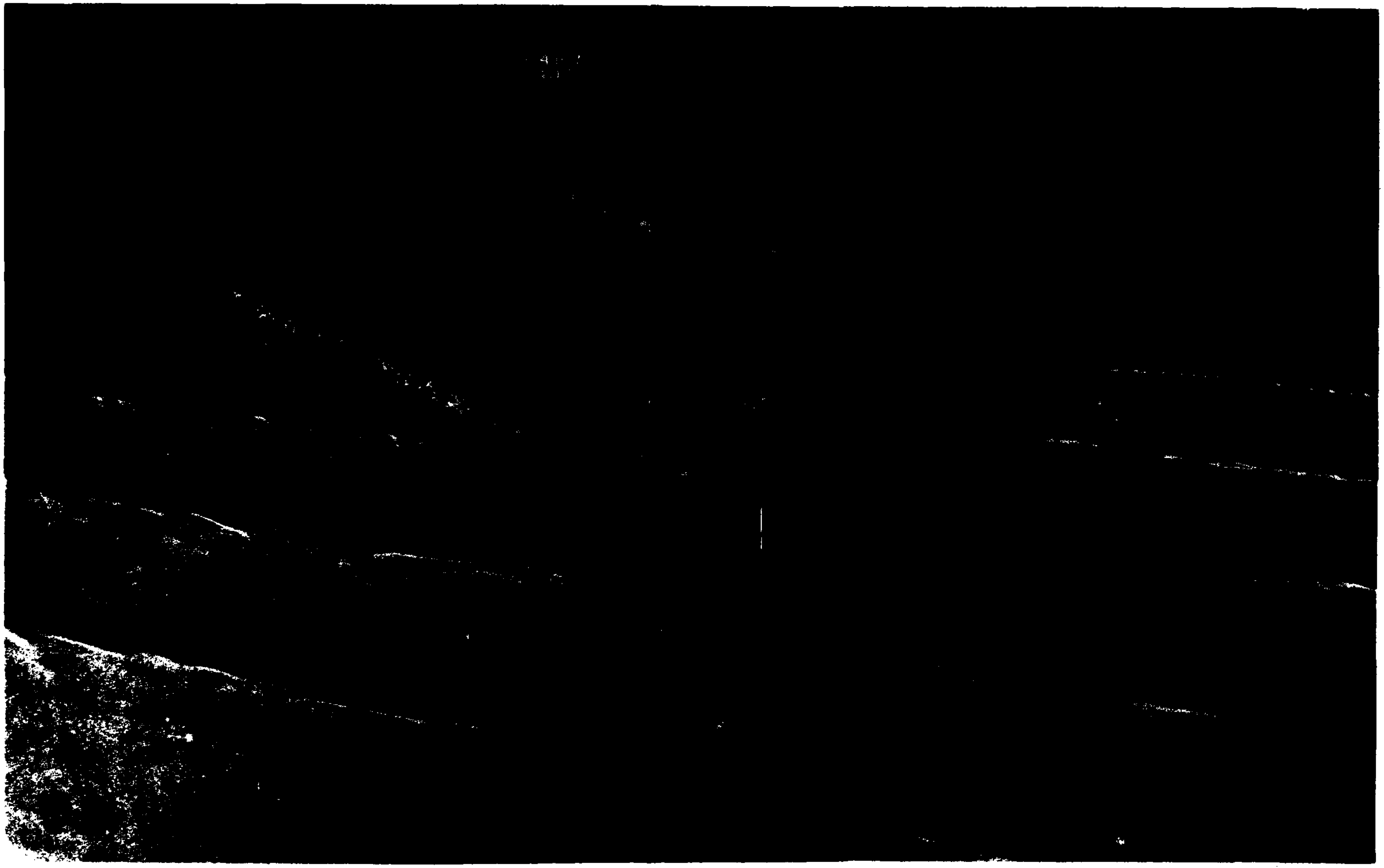


Photo 374. Typical wave patterns obtained for Plan 8D; 11-sec, 12-ft waves from west; swl = +6.7 ft

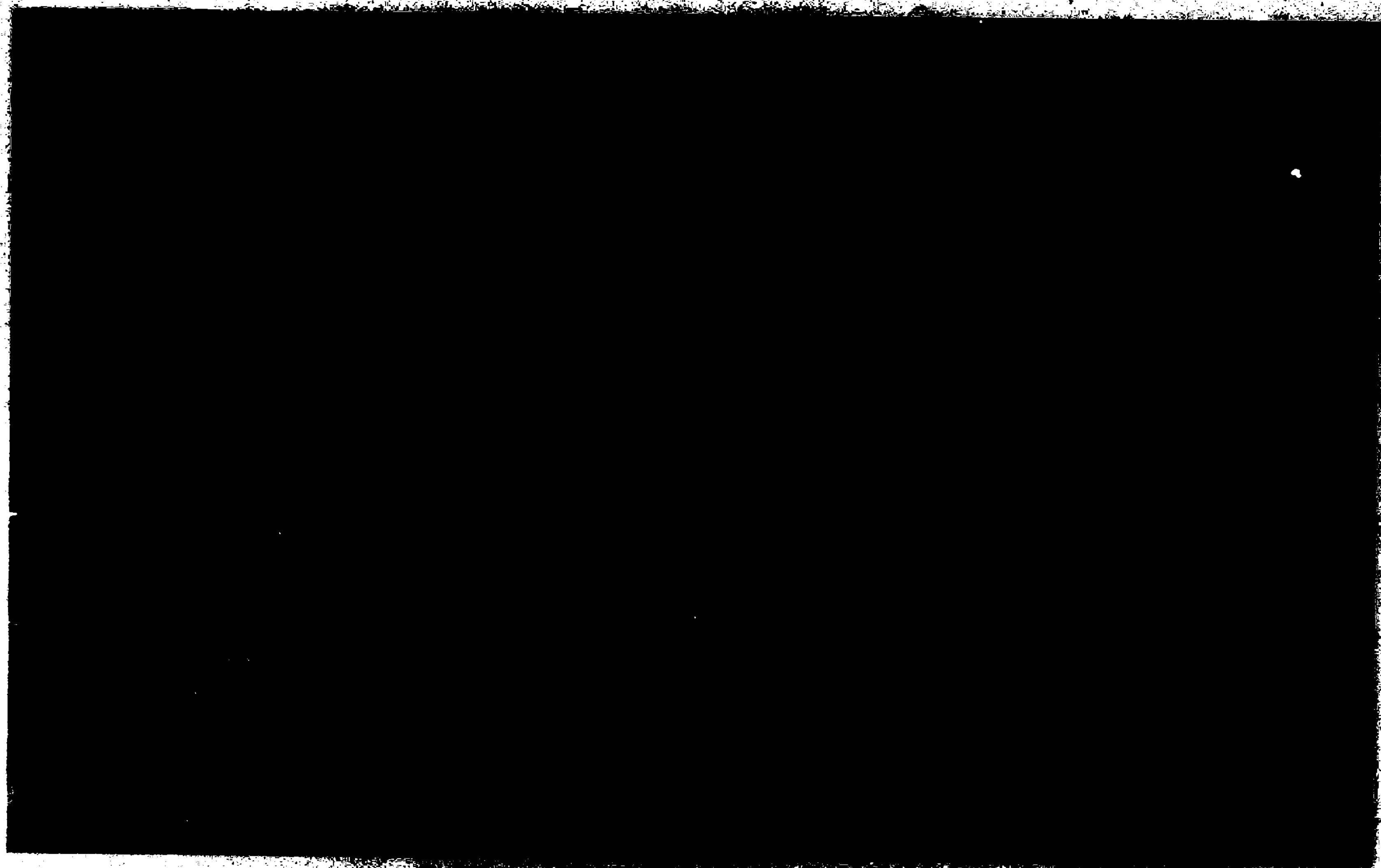


Photo [illegible]. [illegible] outlined for Plan 8D;
11-sec, [illegible]-ft waves from [illegible]; swl = +6.7 ft

Photo 376. Typical wave patterns obtained for Plan 8D; 11-sec, 12-ft waves from SSW; swl = +6.7 ft

Photo 377. Shoal formed for Plan 8D; 11-sec, 13-ft waves from SW

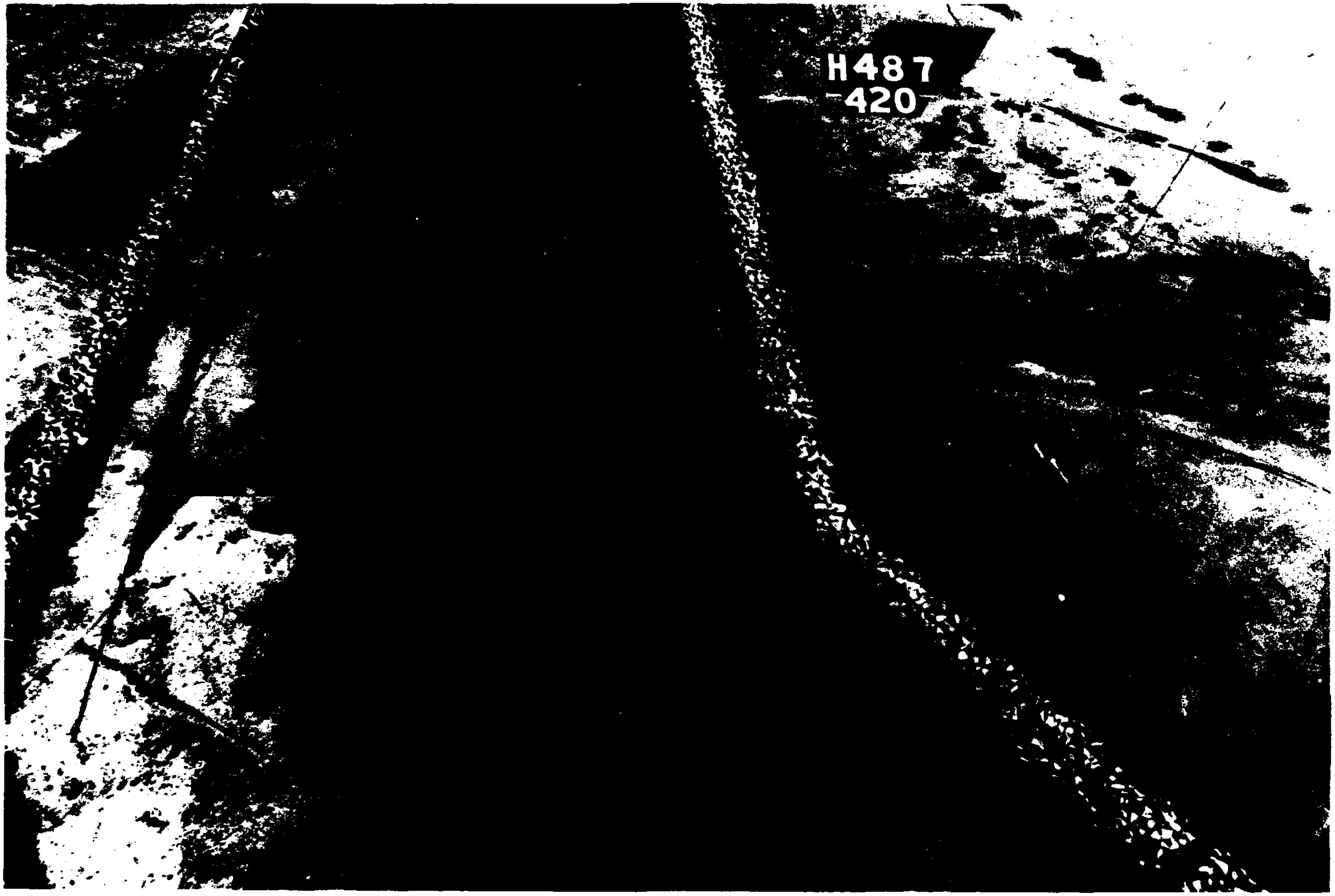


Photo 378. Closer view of shoal formed by 11-sec, 13-ft waves from SW for Plan 8D

Photo 379. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10; swl = +6.7 ft

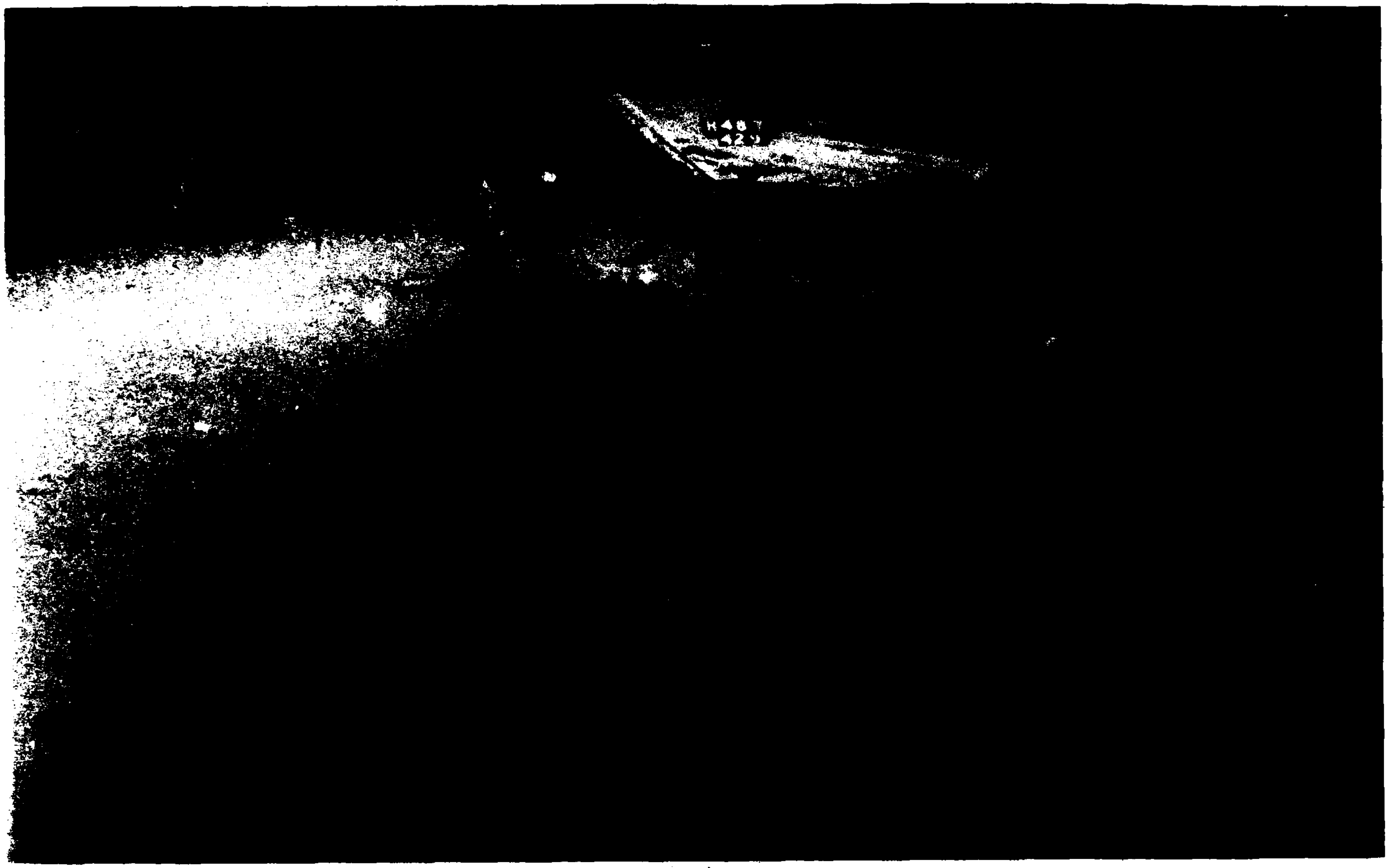


Photo 380. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10A; swl = +6.7 ft

Photo 381. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10B; swl = +6.7 ft

Photo 382. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10C; swl = +6.7 ft

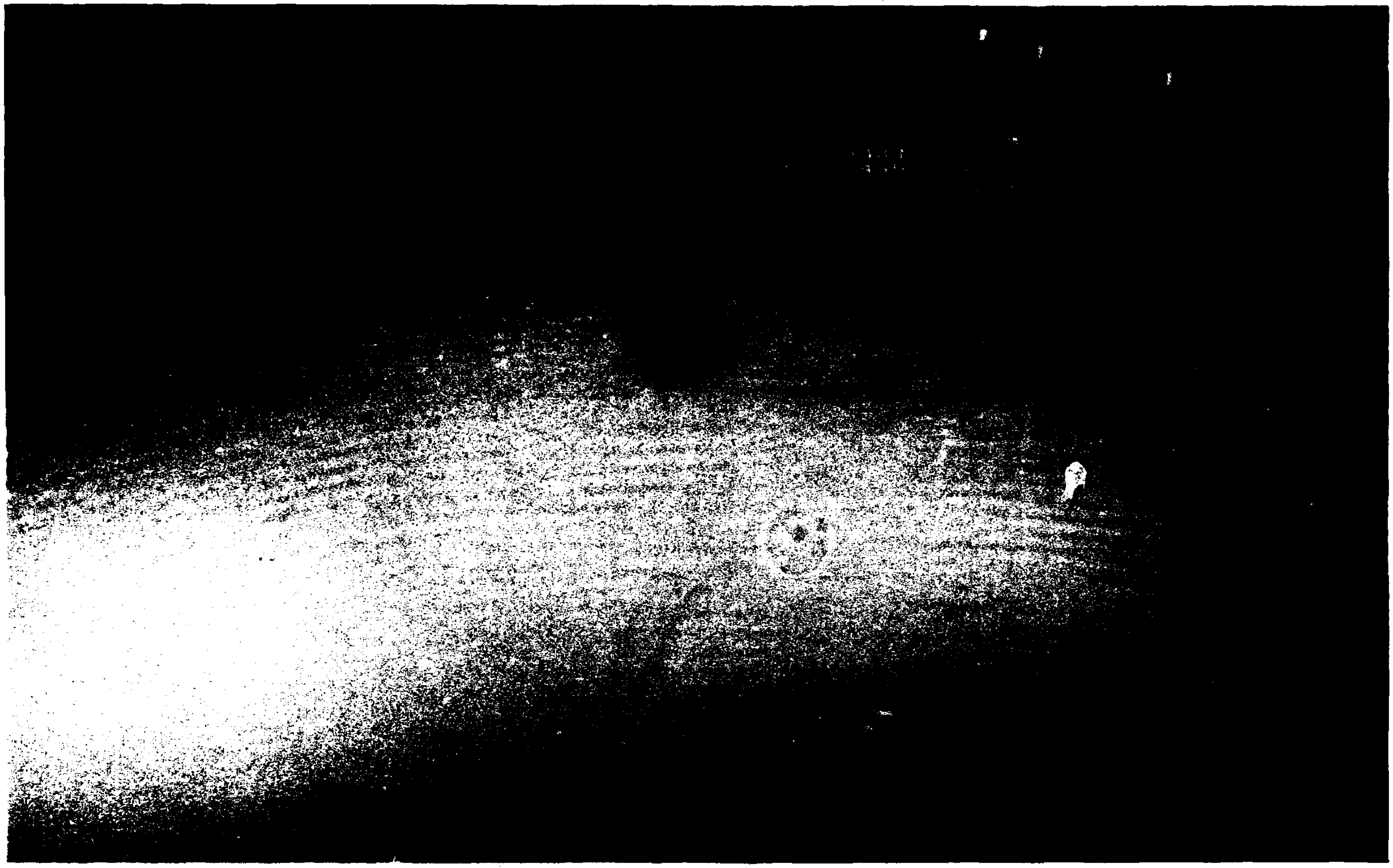


Photo 383. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10D; swl = +6.7 ft

Photo 384. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10E; swl = +6.7 ft

Photo 385. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10F; swl = +6.7 ft

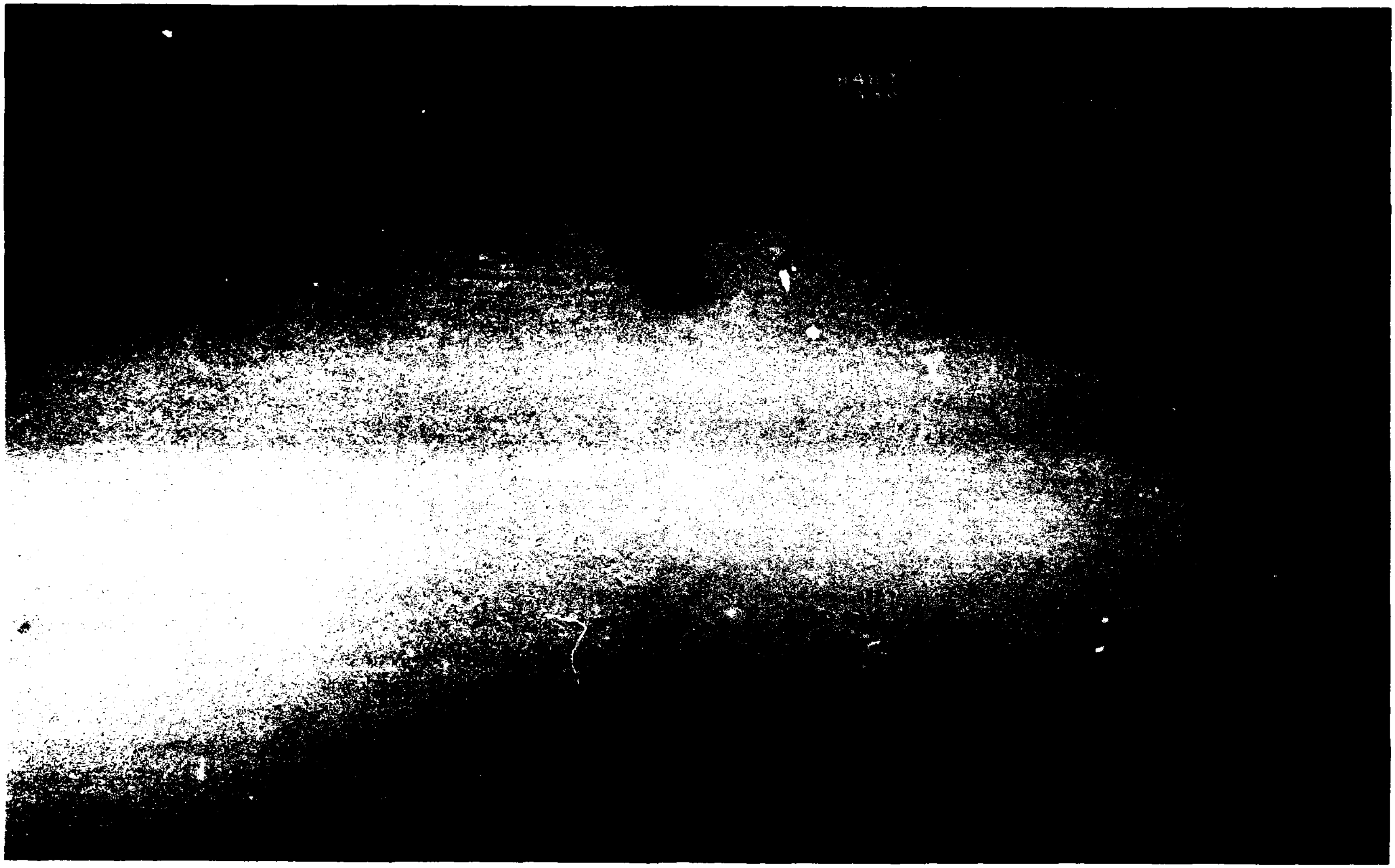


Photo 386. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 10G; swl = +6.7 ft

Photo 387. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10G; swl = +6.7 ft

Photo 388. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10H; swl = +6.7 ft

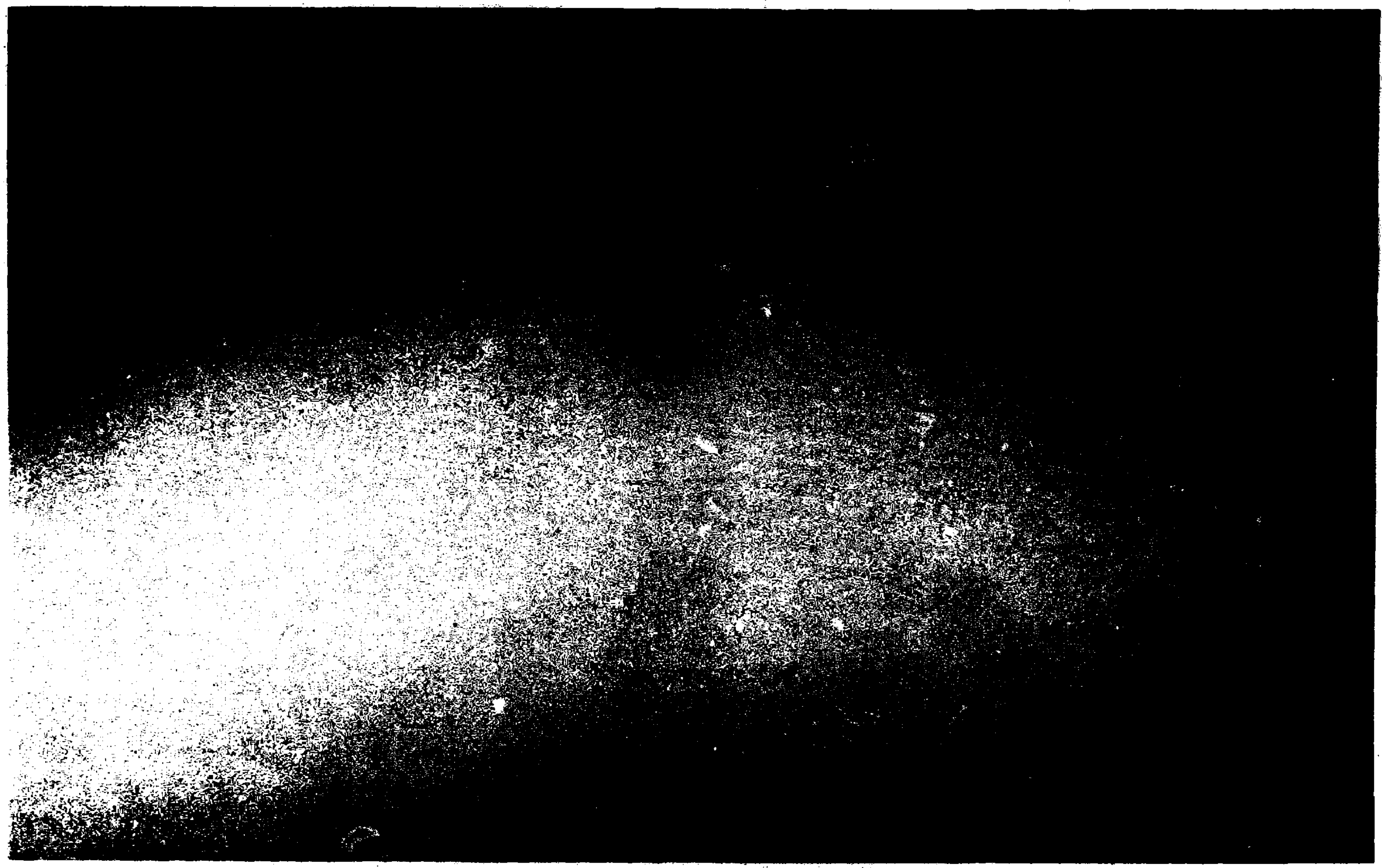


Photo 391. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 10J; swl = +6.7 ft

Photo 392. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 10J; swl = +6.7 ft

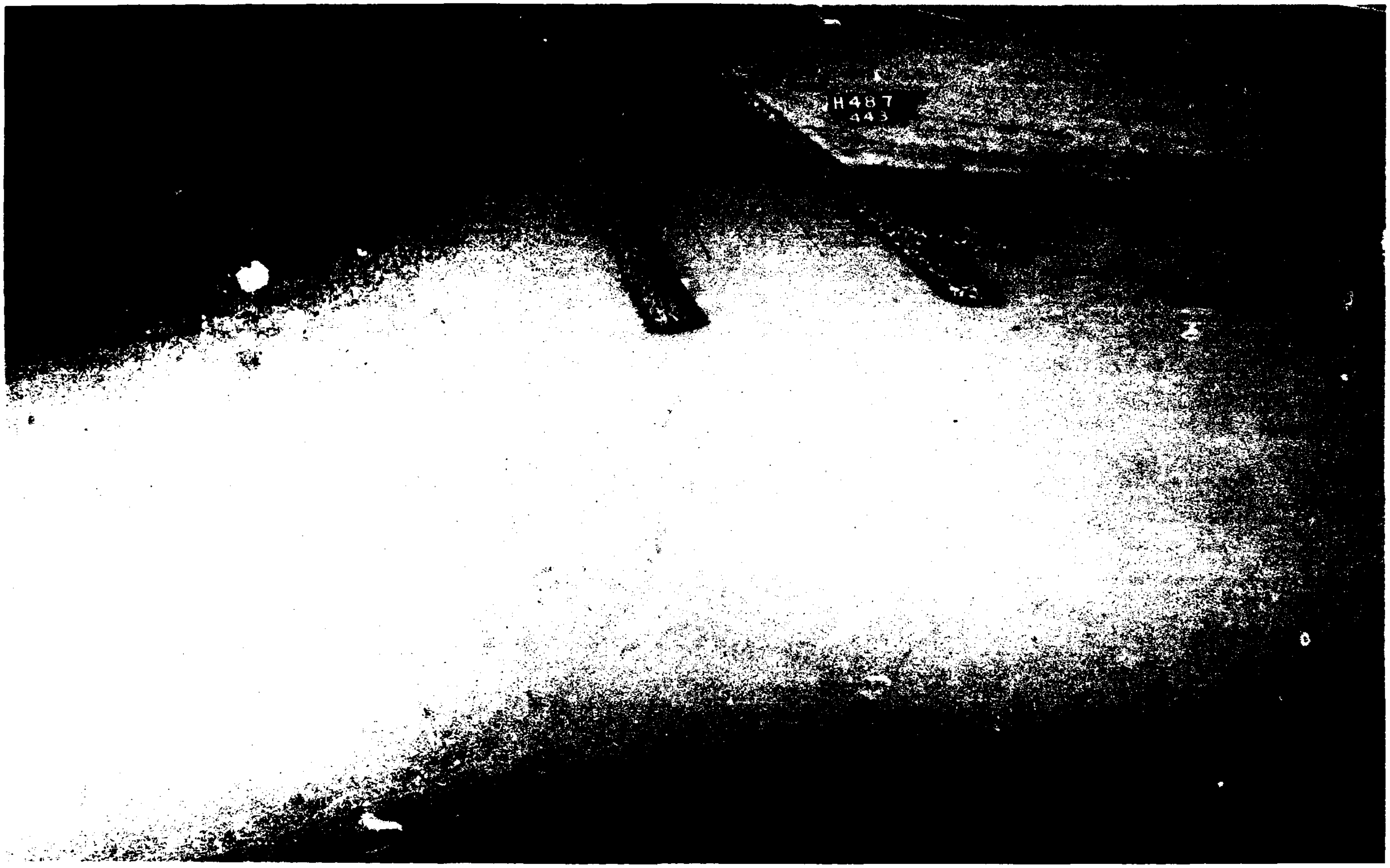


Photo 393. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 10J; swl = 0.0 ft

Photo 394. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 10J; swl = 0.0 ft

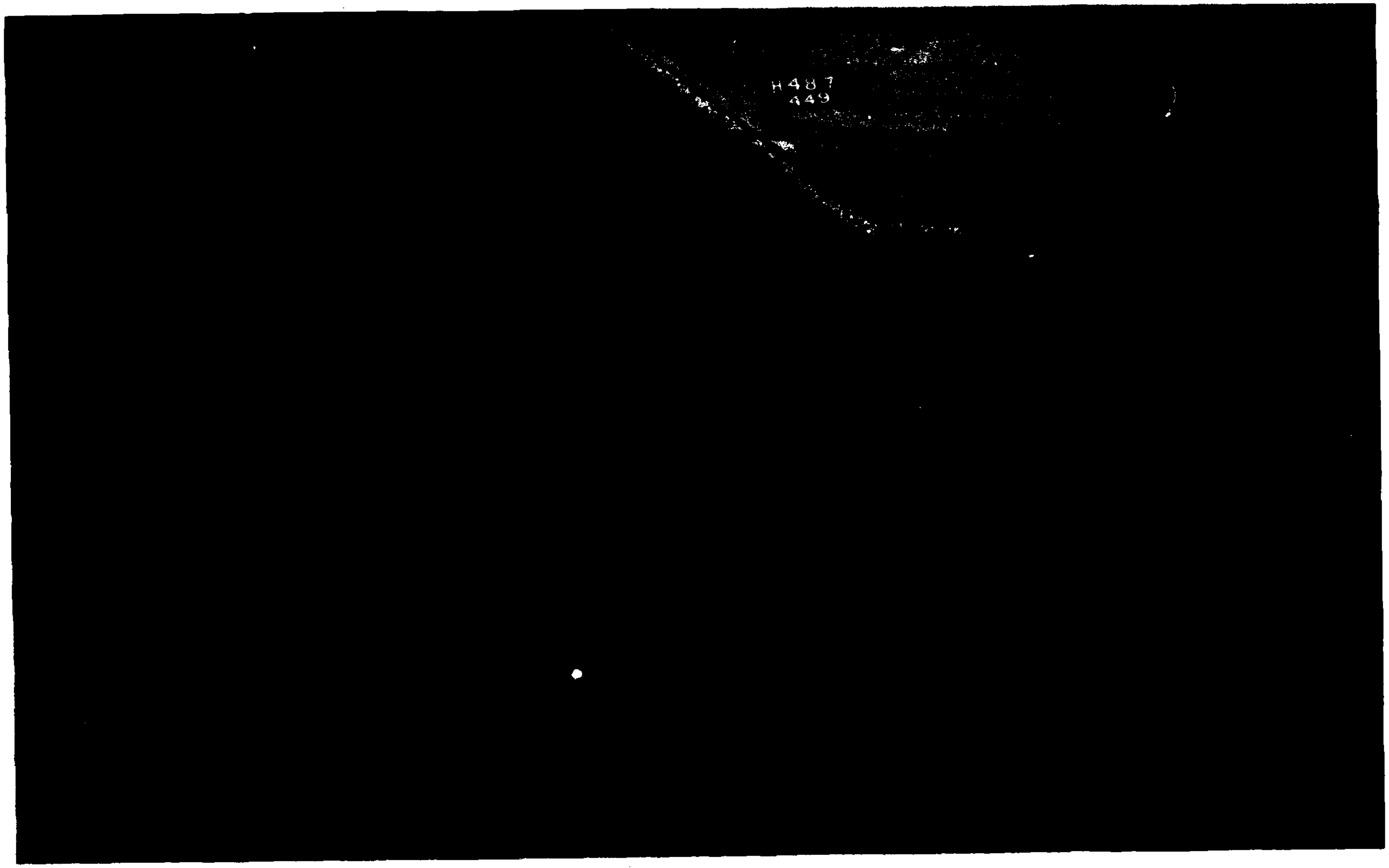


Photo 395. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 11; swl = 0.0 ft

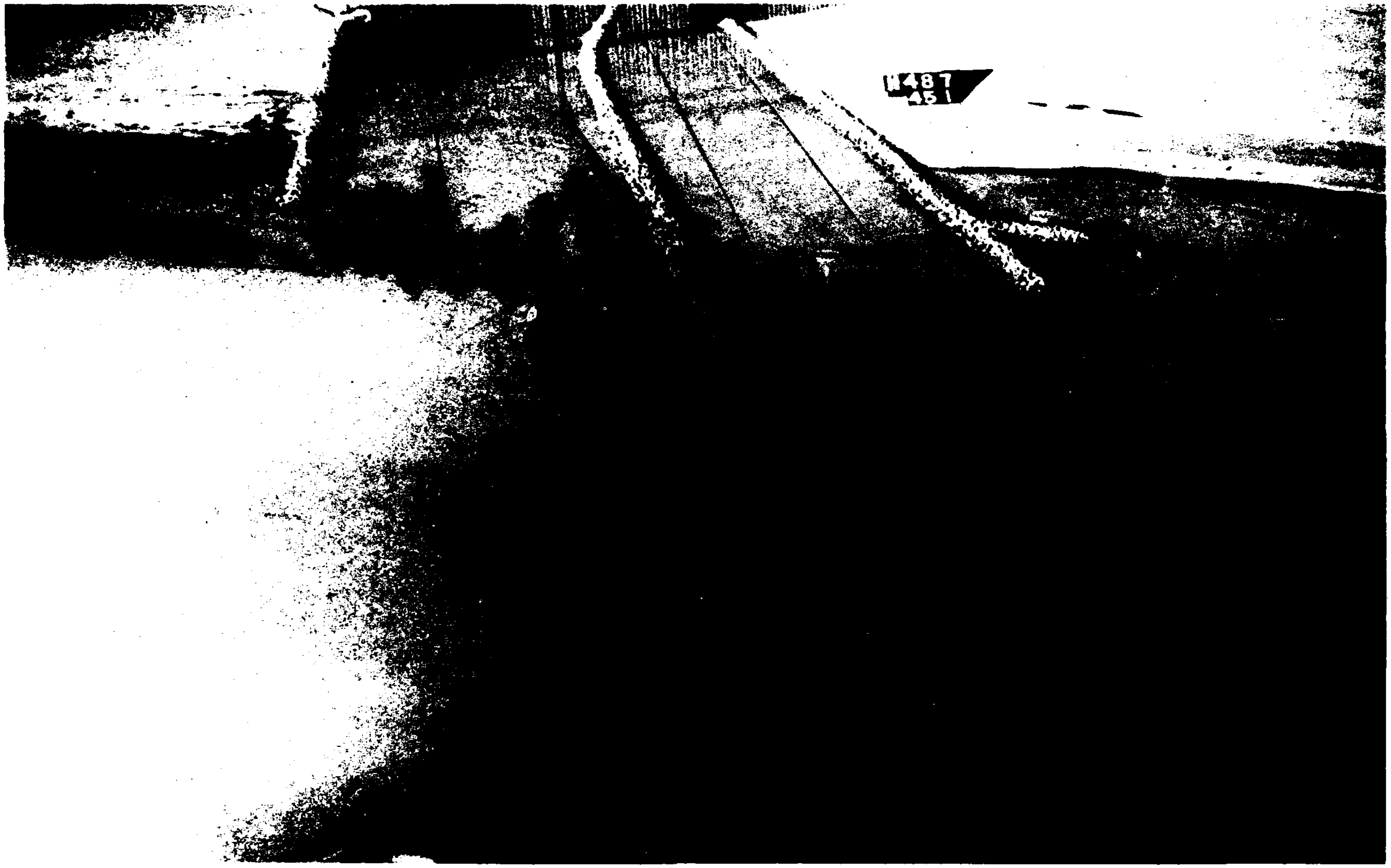


Photo 396. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 11A; swl = 0.0 ft

Photo 397. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 11B; swl = 0.0 ft

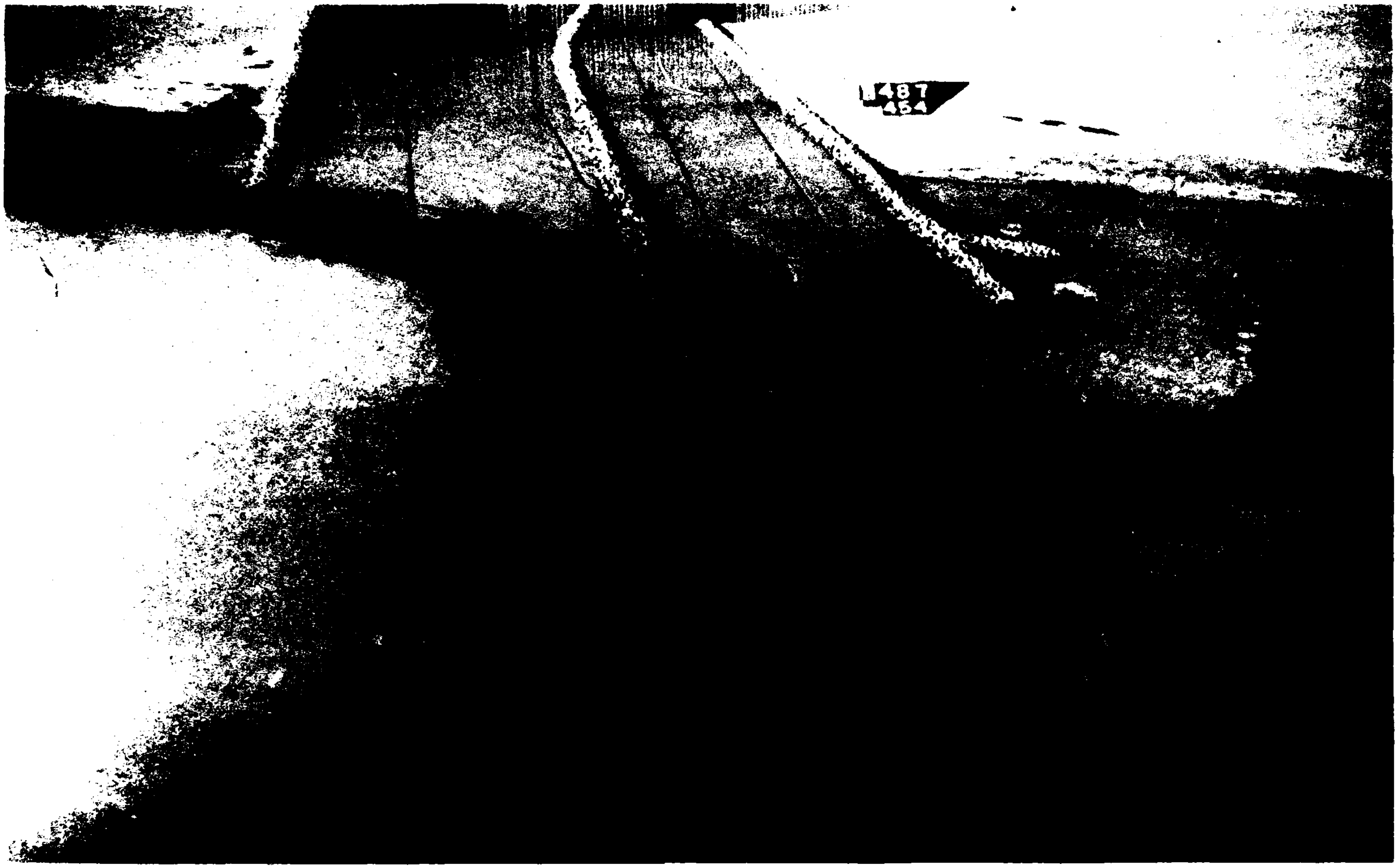


Photo 398. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 11B; swl = 0.0 ft

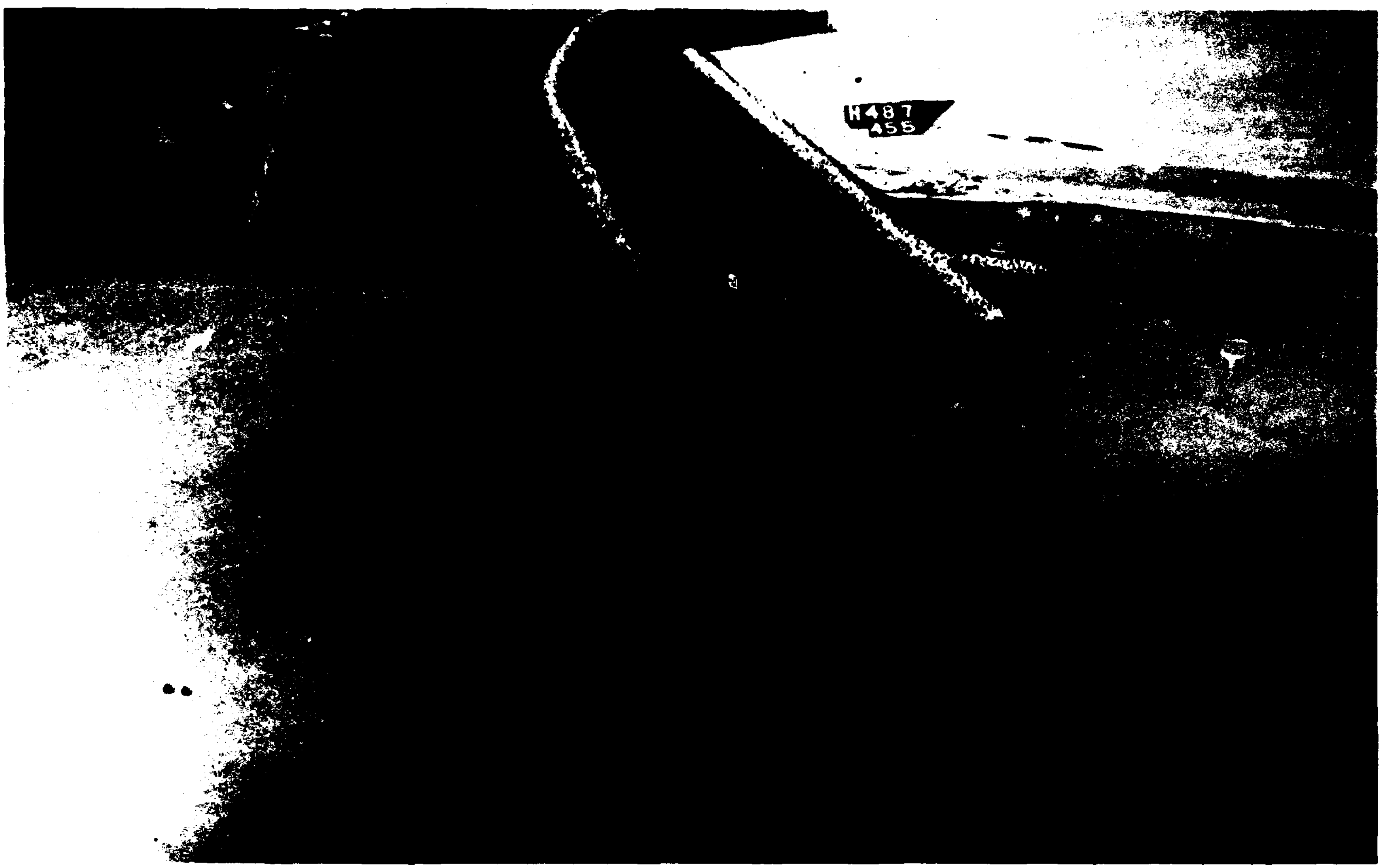


Photo 399. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 11B; swl = 0.0 ft

Photo 400. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from NNW for Plan 11B; swl = +6.7 ft

Photo 401. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from NNW for Plan 11B; swl = +6.7 ft

Photo 402. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from NNW for Plan 11B; swl = +6.7 ft

Photo 403. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for Plan 11B; swl = 0.0 ft

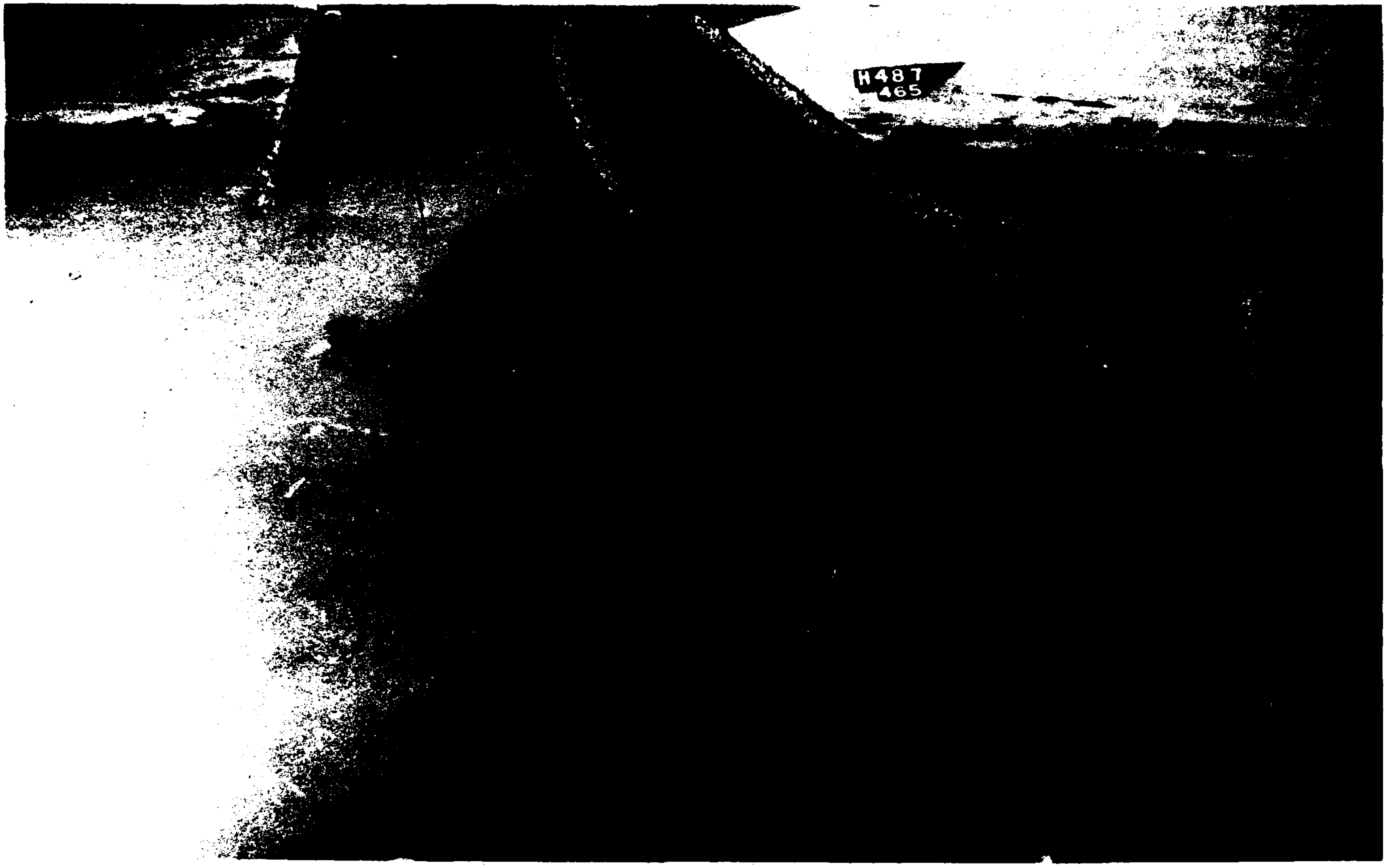


Photo 404. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for Plan 11B; swl = 0.0 ft

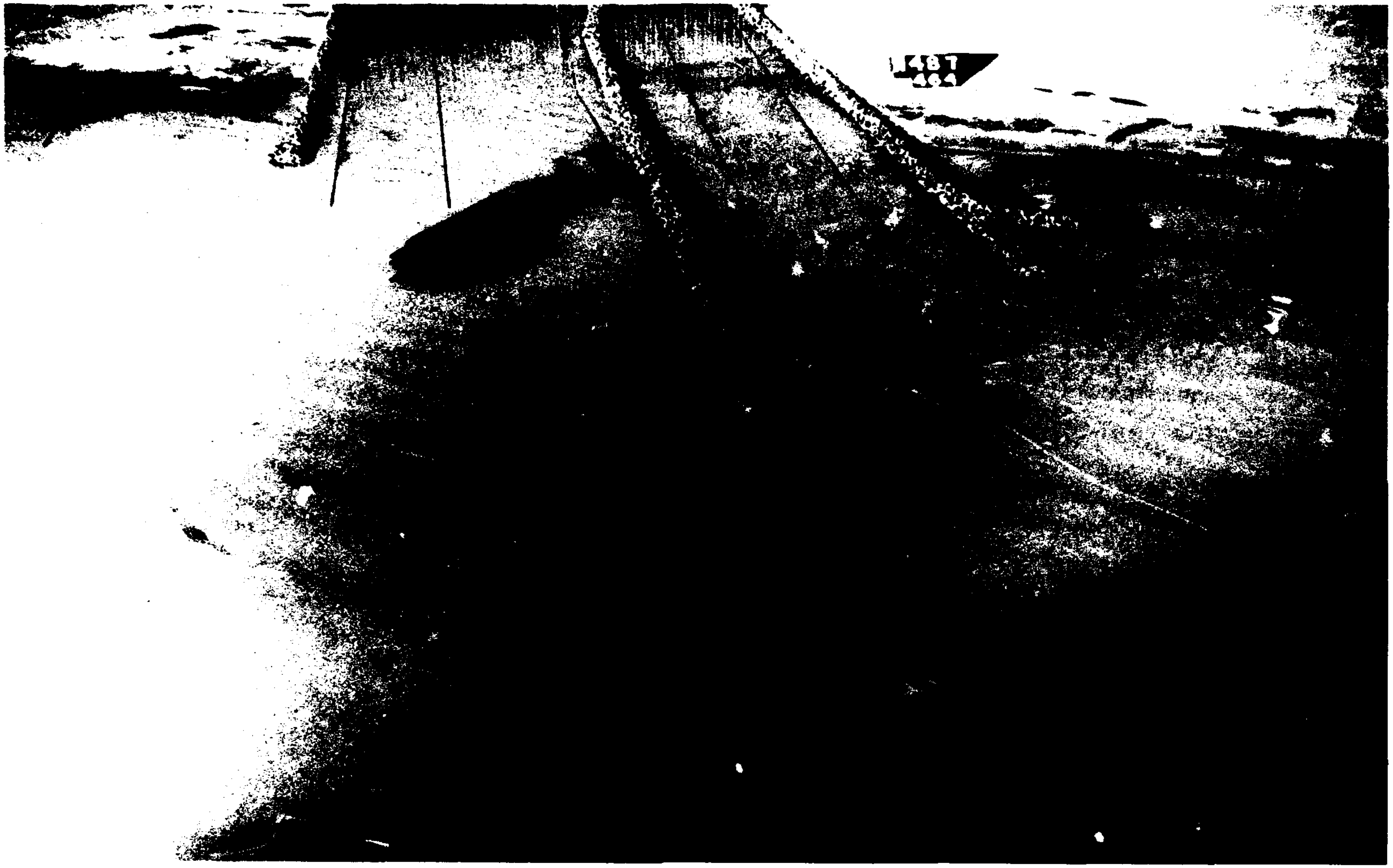


Photo 405. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for Plan 11B; swl = 0.0 ft

Photo 406. General movement of tracer material and deposits resulting from 9-sec, 23-ft waves from west for Plan 11B; swl = +6.7 ft

Photo 407. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from west for Plan 11B; swl = +6.7 ft

Photo 408. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from west for Plan 11B; swl = +6.7 ft

Photo 409. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for Plan 11B; swl = 0.0 ft

Photo 410. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for Plan 11B; swl = 0.0 ft

Photo 411. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for Plan 11B; swl = 0.0 ft

Photo 412. General movement of tracer material and deposits resulting from 9-sec, 21-ft waves from SW for Plan 11B; swl = +6.7 ft

Photo 413. General movement of tracer material and deposits resulting from 11-sec, 13-ft waves from SW for Plan 11B; swl = +6.7 ft

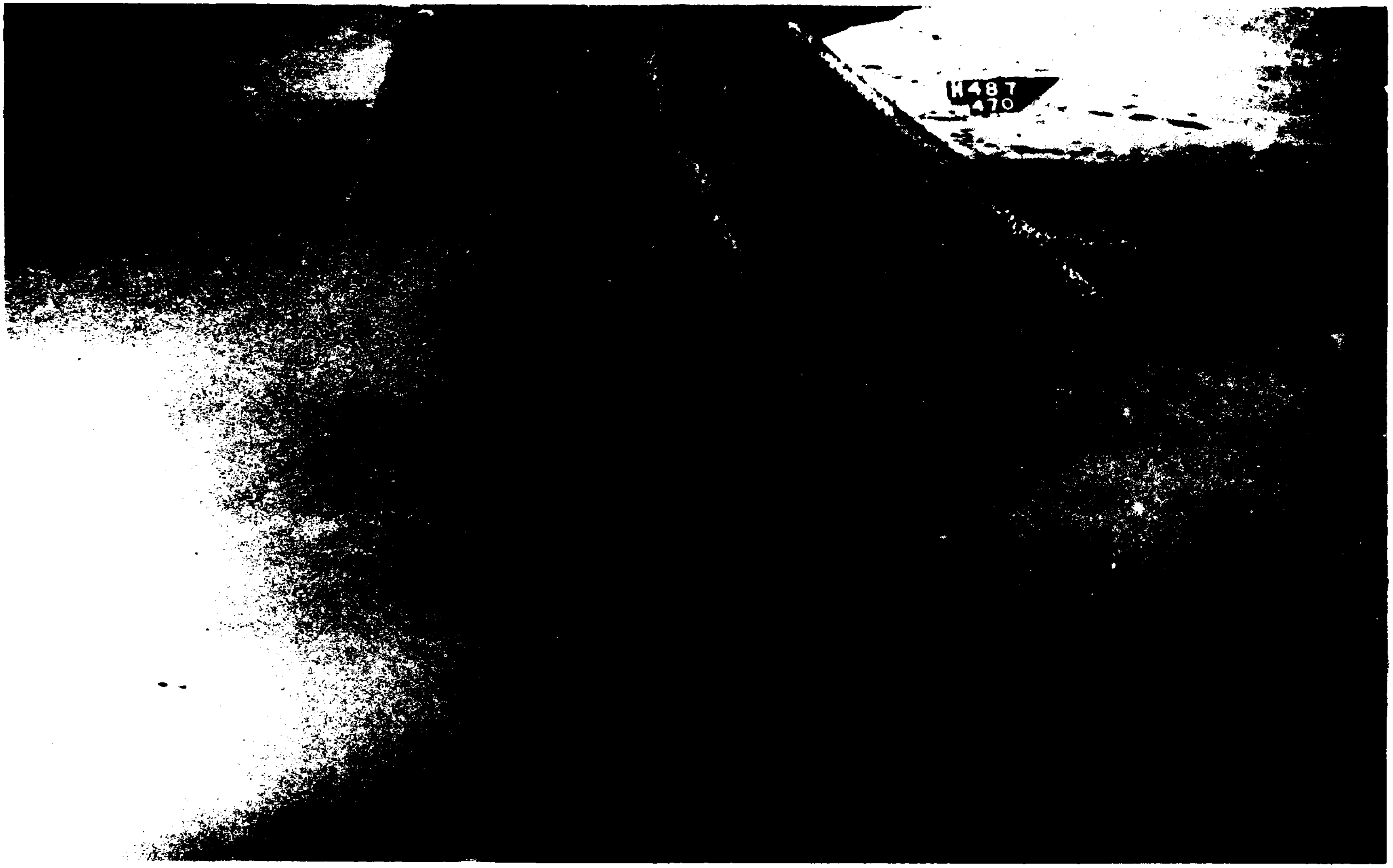


Photo 414. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SW for Plan 11B; swl = +6.7 ft

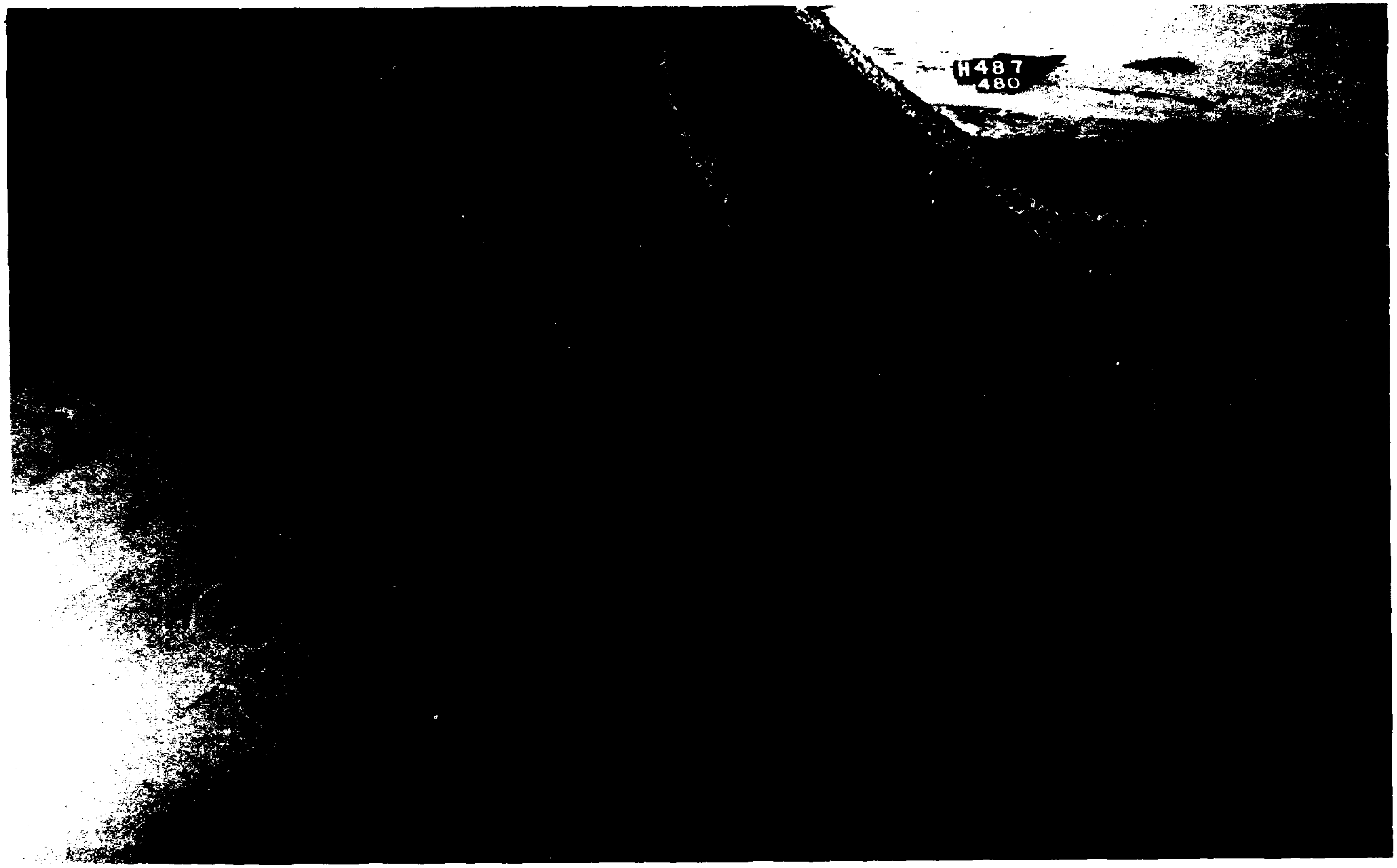


Photo 415. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 11B; swl = 0.0 ft

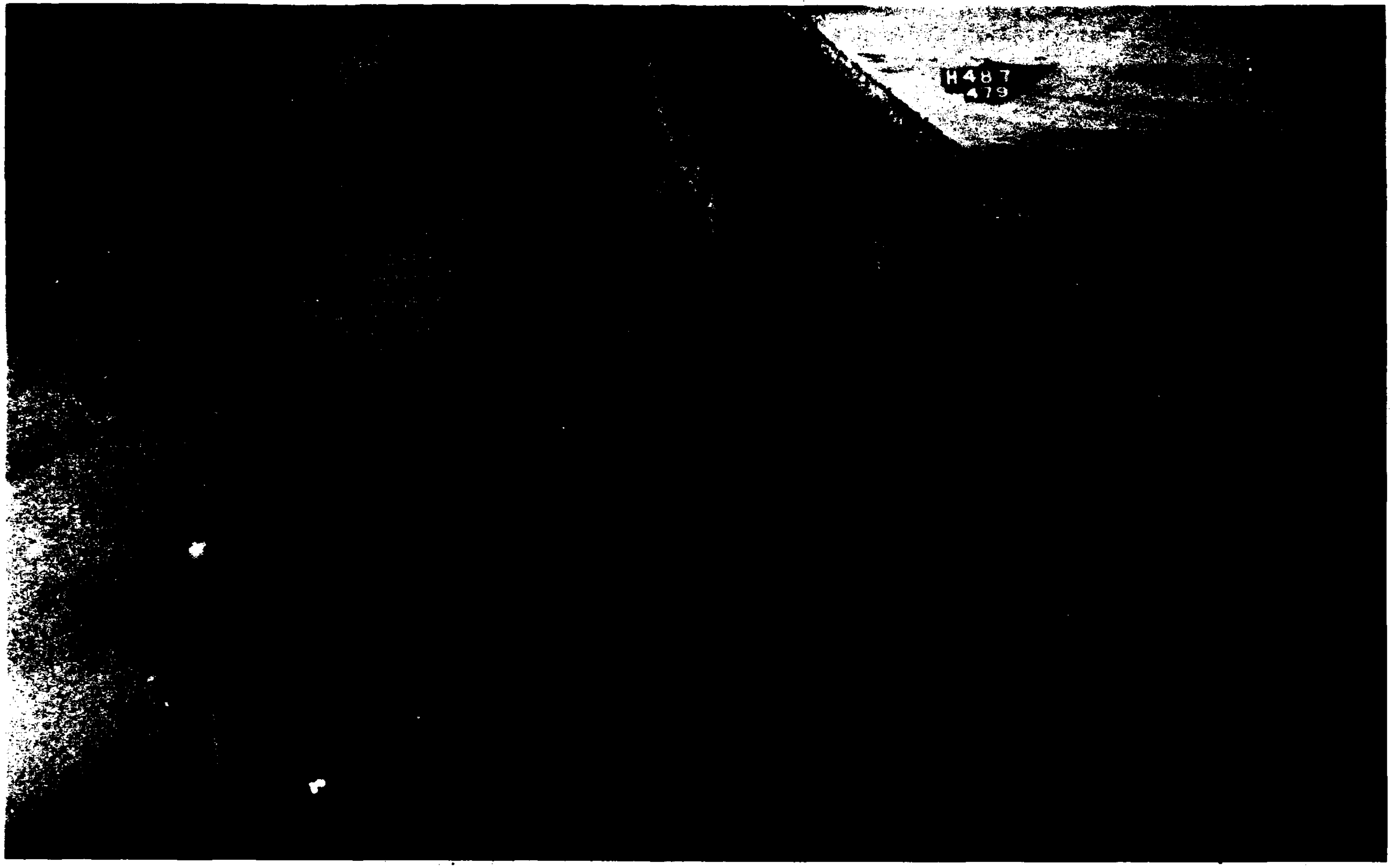


Photo 416. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 11B; swl = 0.0 ft

Photo 417. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 11B; swl = 0.0 ft

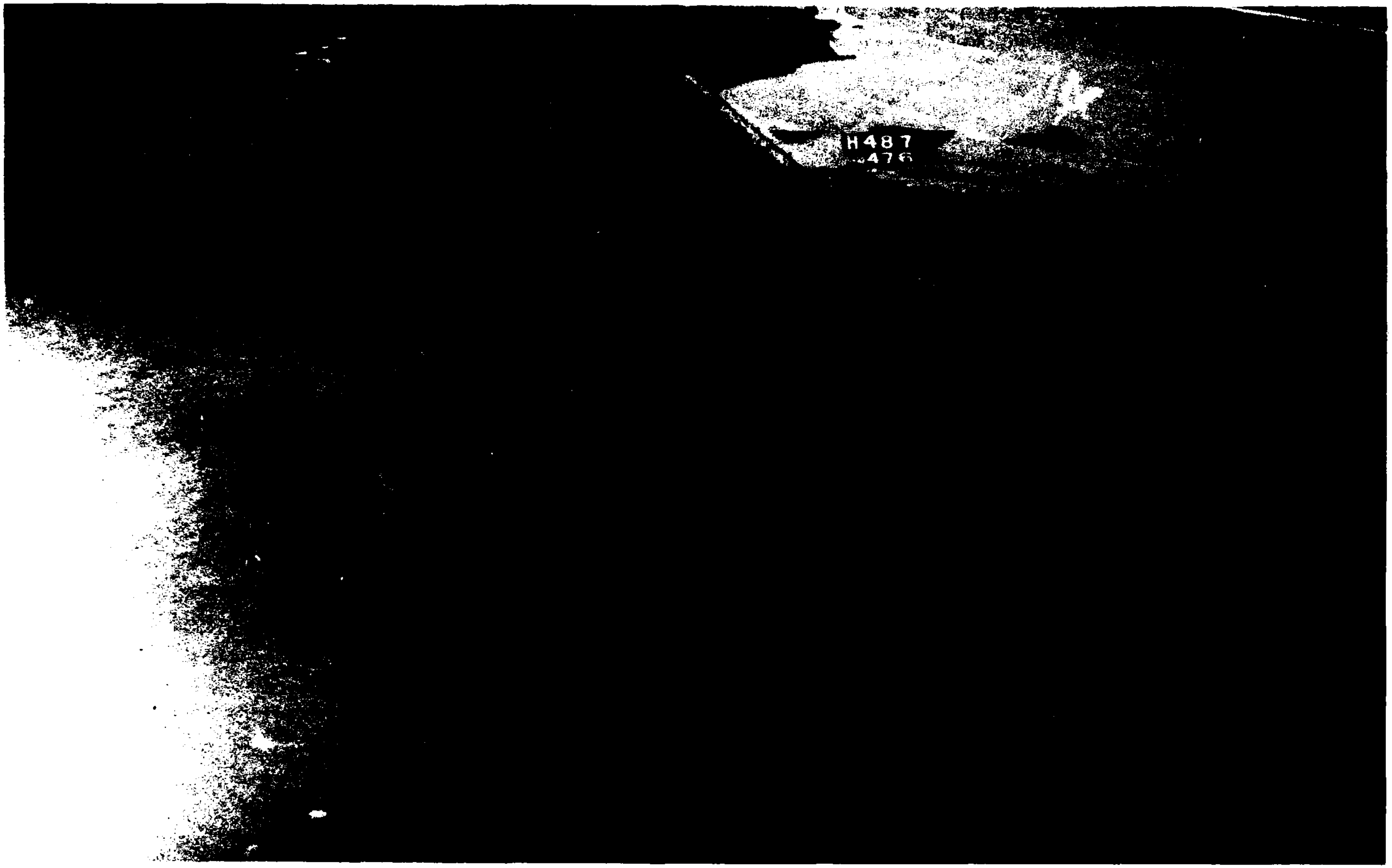


Photo 418. General movement of tracer material and deposits resulting from 9-sec, 27-ft waves from SSW for Plan 11B; swl = +6.7 ft

Photo 419. General movement of tracer material and deposits resulting from 11-sec, 12-ft waves from SSW for Plan 11B; swl = +6.7 ft

Photo 420. General movement of tracer material and deposits resulting from 13-sec, 7-ft waves from SSW for Plan 11B; swl = +6.7 ft

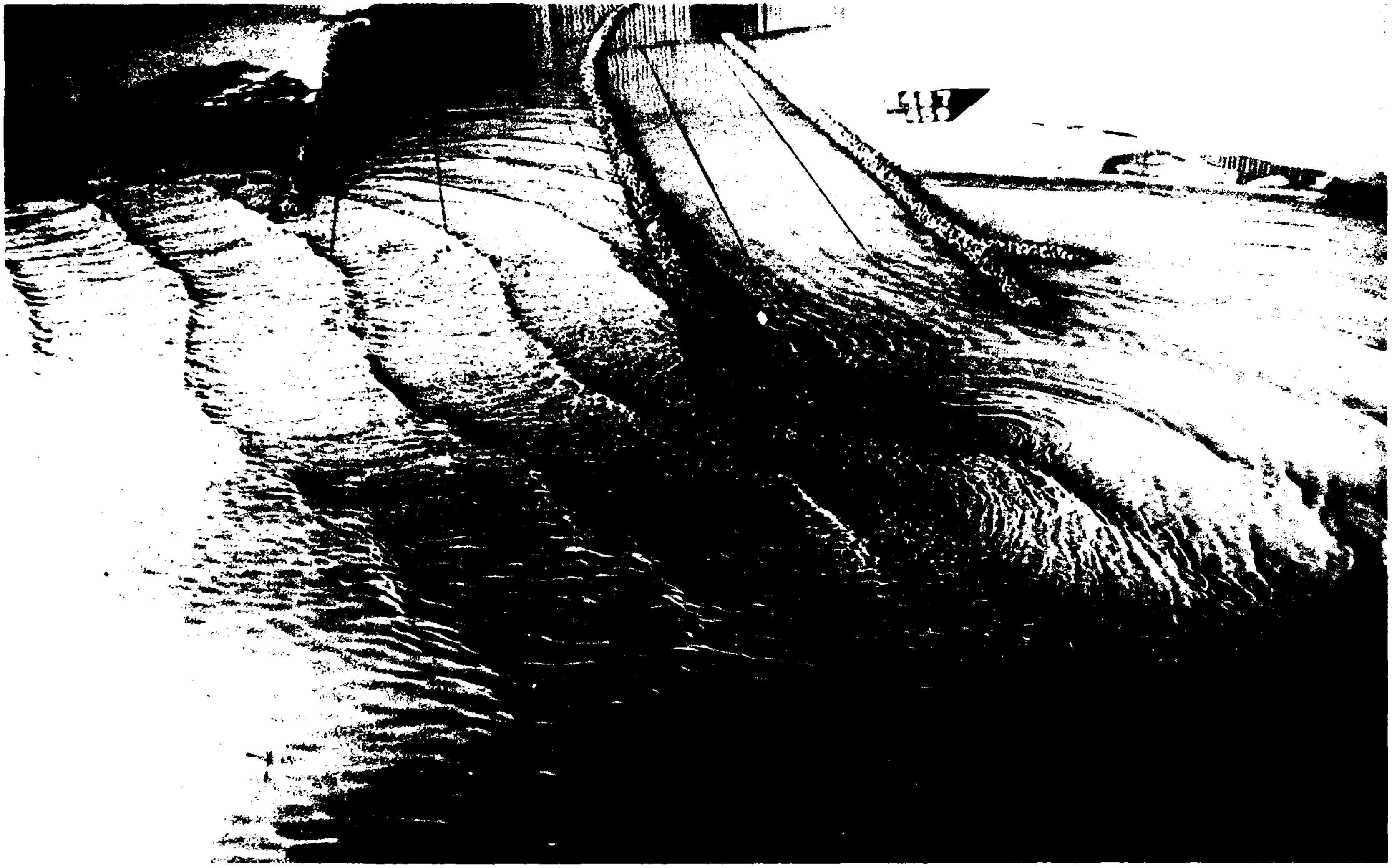


Photo 421. Typical wave patterns obtained for Plan 11B; 11-sec, 12-ft waves from NNW; swl = +6.7 ft

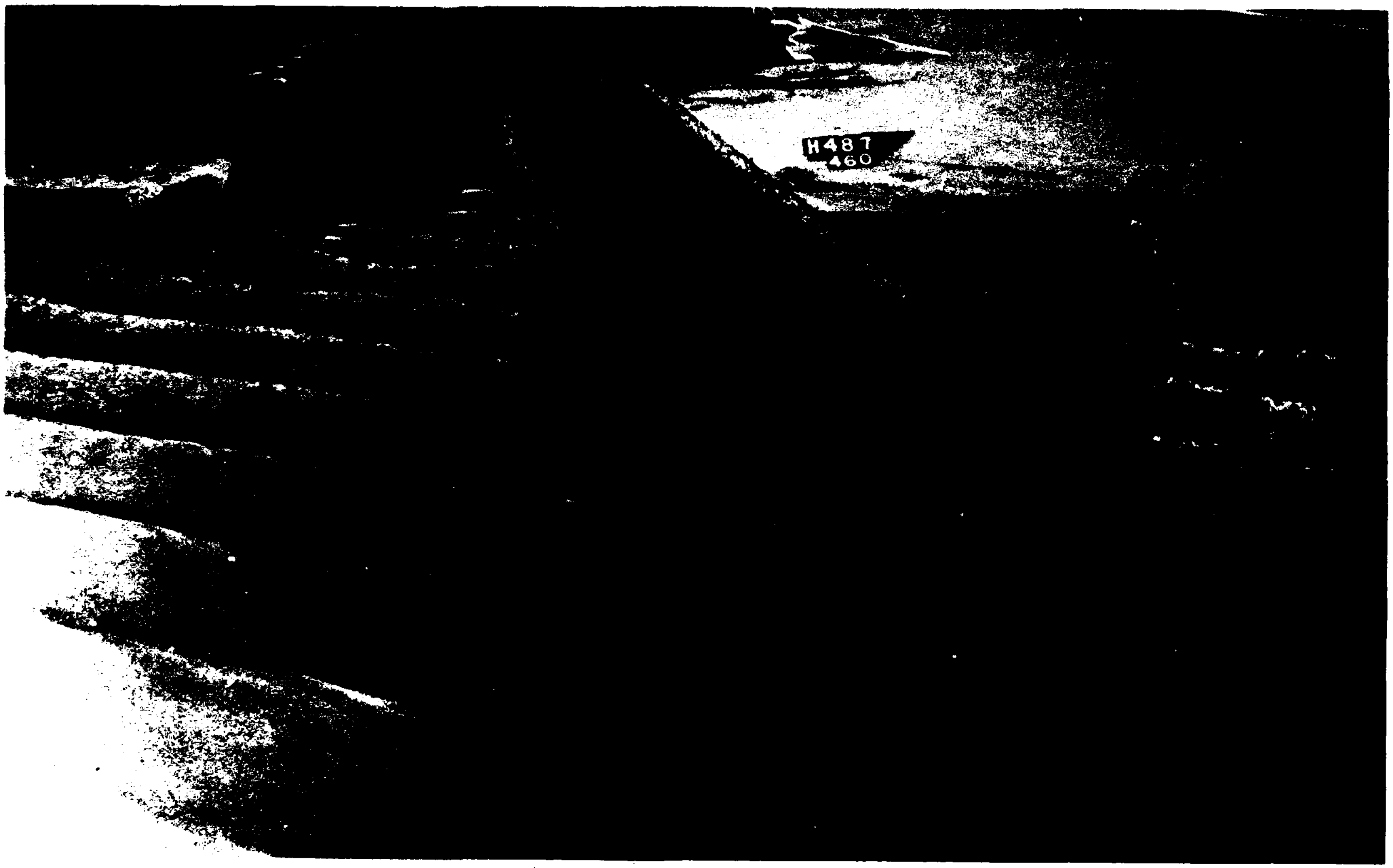


Photo 422. Typical wave patterns obtained for Plan 11B; 11-sec, 12-ft waves from west; swl = +6.7 ft

Photo 423. Typical wave patterns obtained for Plan 11B; 11-sec, 13-ft waves from SW; swl = +6.7 ft

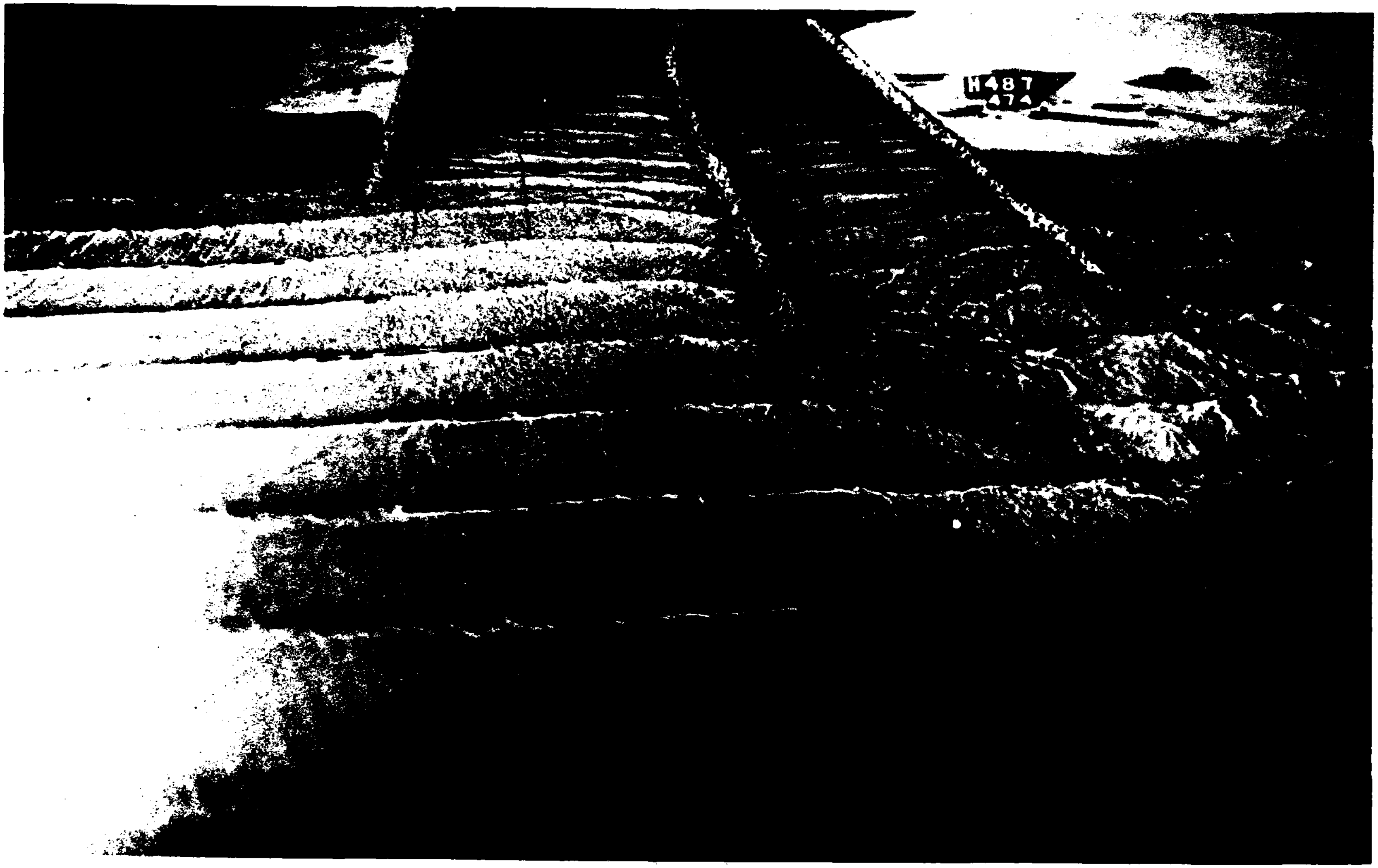


Photo 424. Typical wave patterns obtained for Plan 11B; 11-sec, 12-ft waves from SSW; swl = +6.7 ft

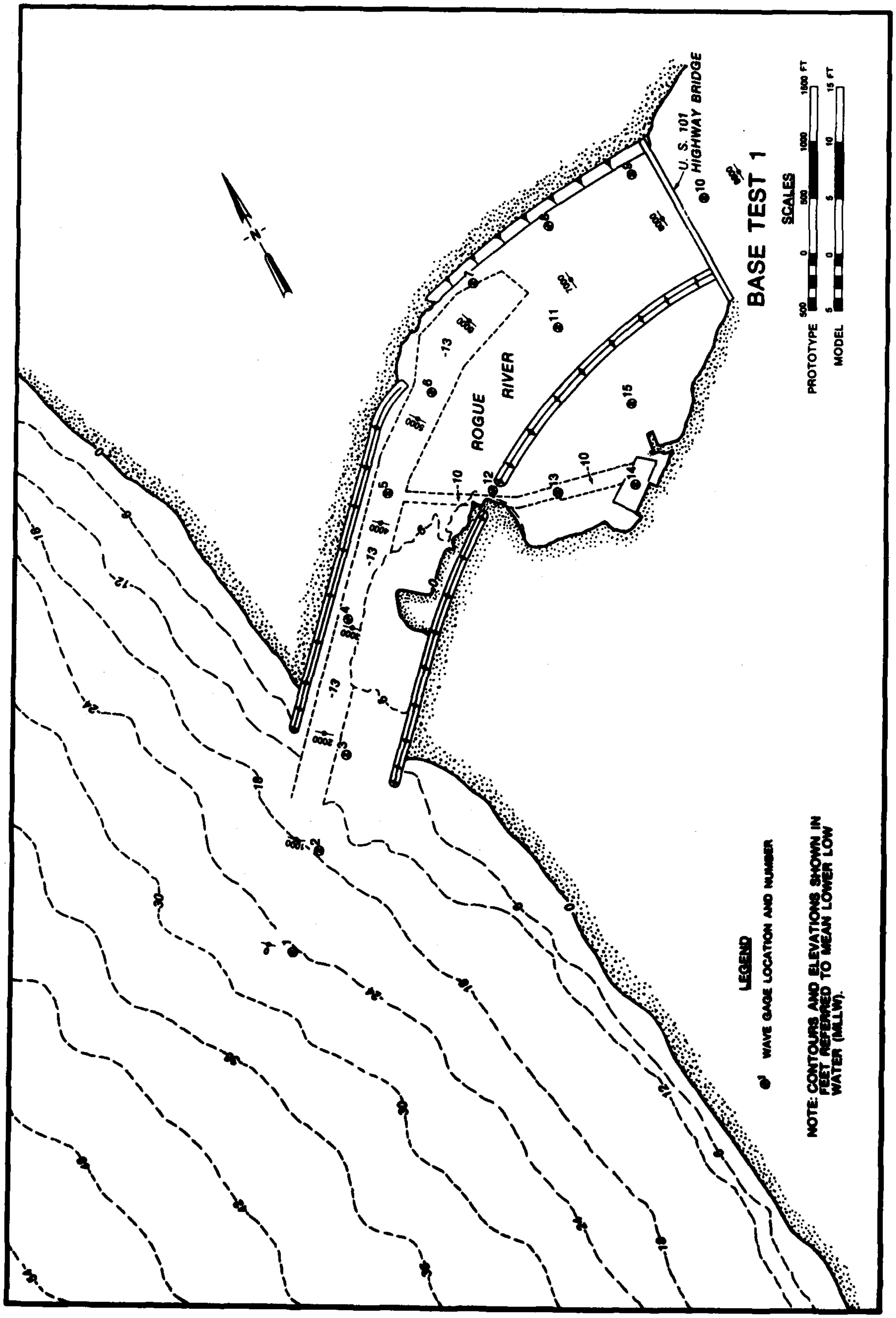

ROGUE
RIVER
U. S. 101 HIGHWAY BRIDGE
BASE TEST 1
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

PLATE 1

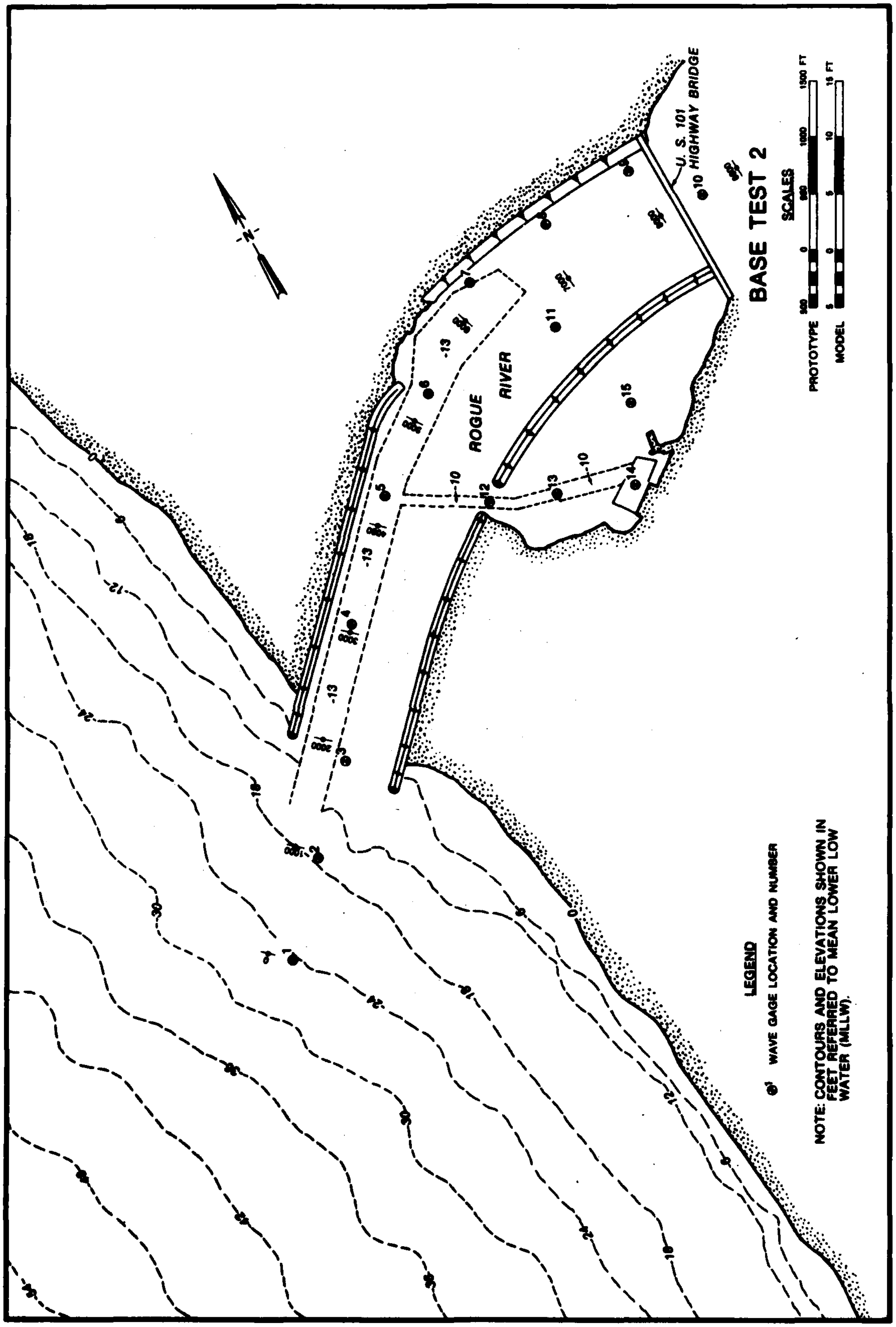

BASE TEST 2
SCALES
PROTOTYPE
MODEL
500 0 500 1000 1500 FT
5 0 5 10 15 FT
U.S. 101 HIGHWAY BRIDGE
ROGUE
RIVER
N
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

PLATE 2

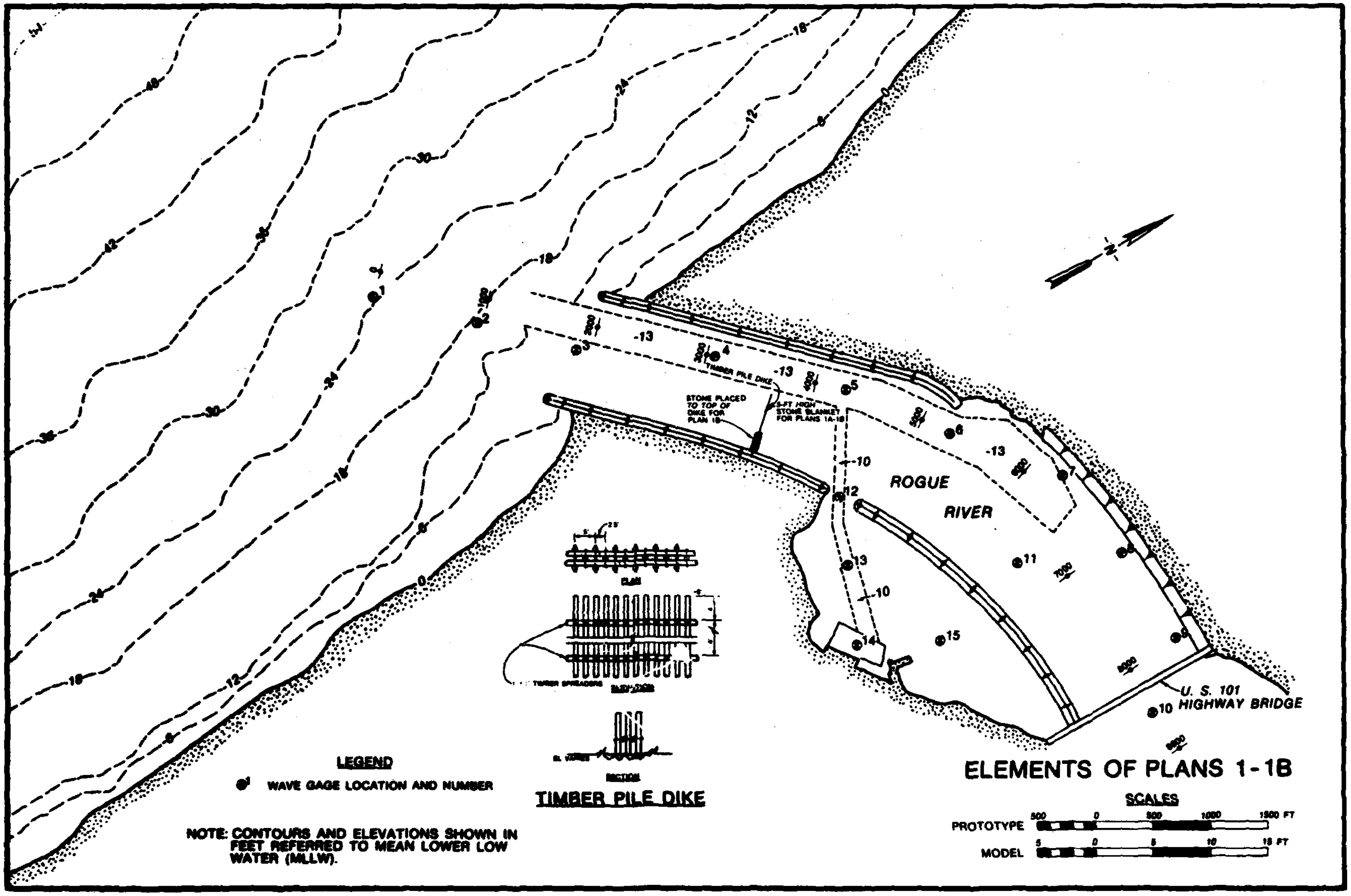

ELEMENTS OF PLANS 1-1B
ROGUE RIVER
U. S. 101 HIGHWAY BRIDGE
STONE PLACED TO TOP OF DIKE FOR PLAN 1B
2-FT HIGH STONE BLANKET FOR PLANS 1A-1B
TIMBER PILE DIKE
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT

PLATE 3

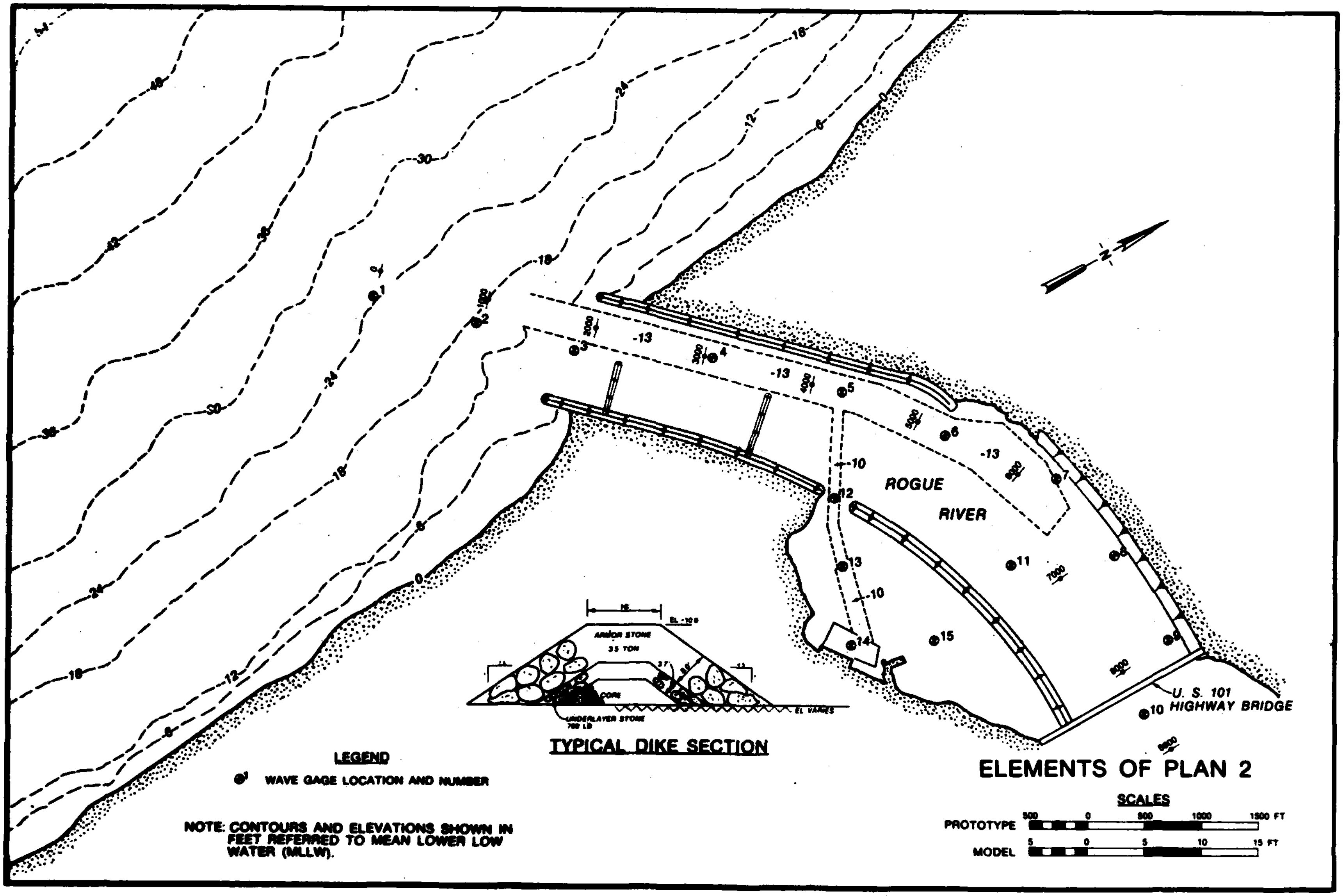
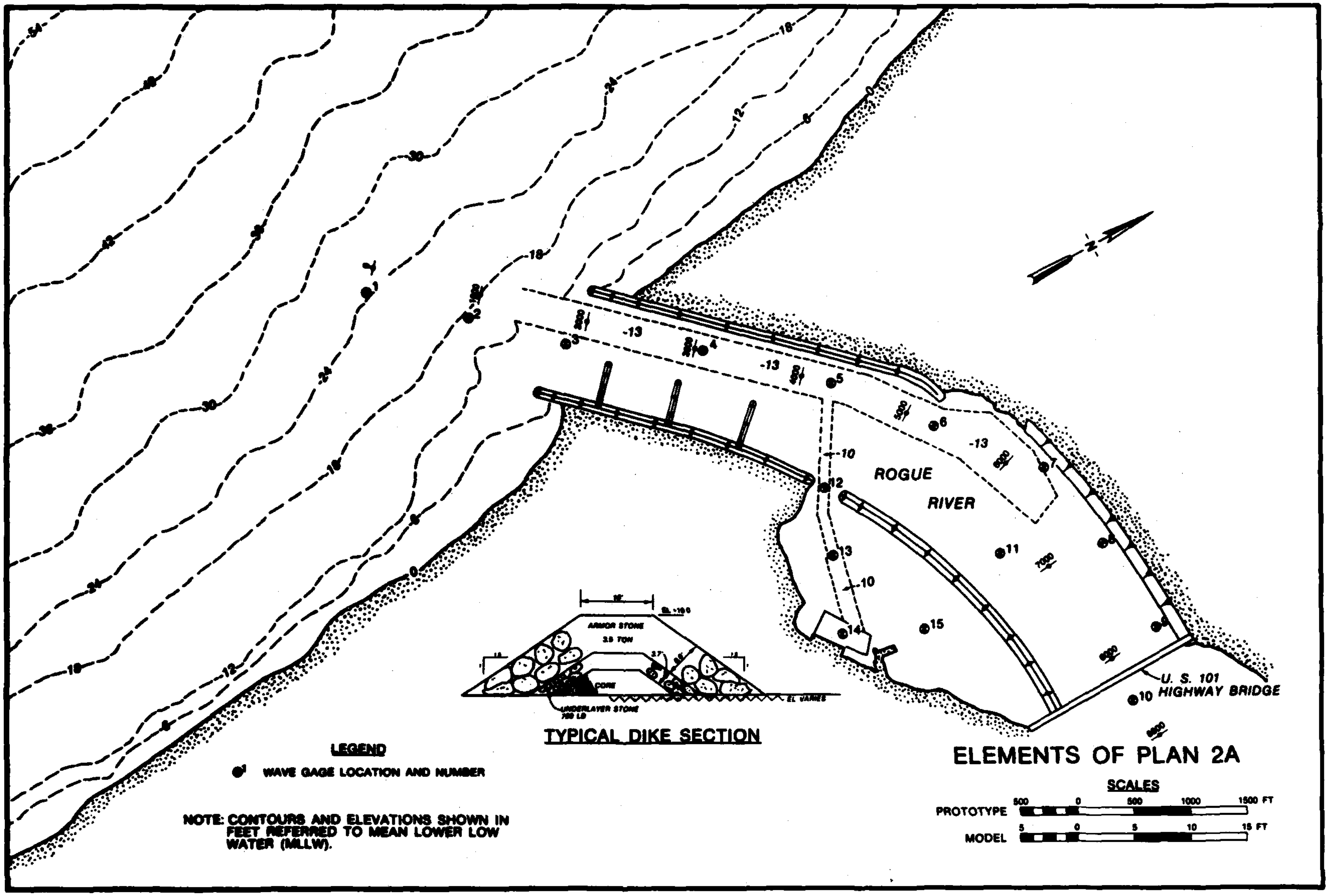
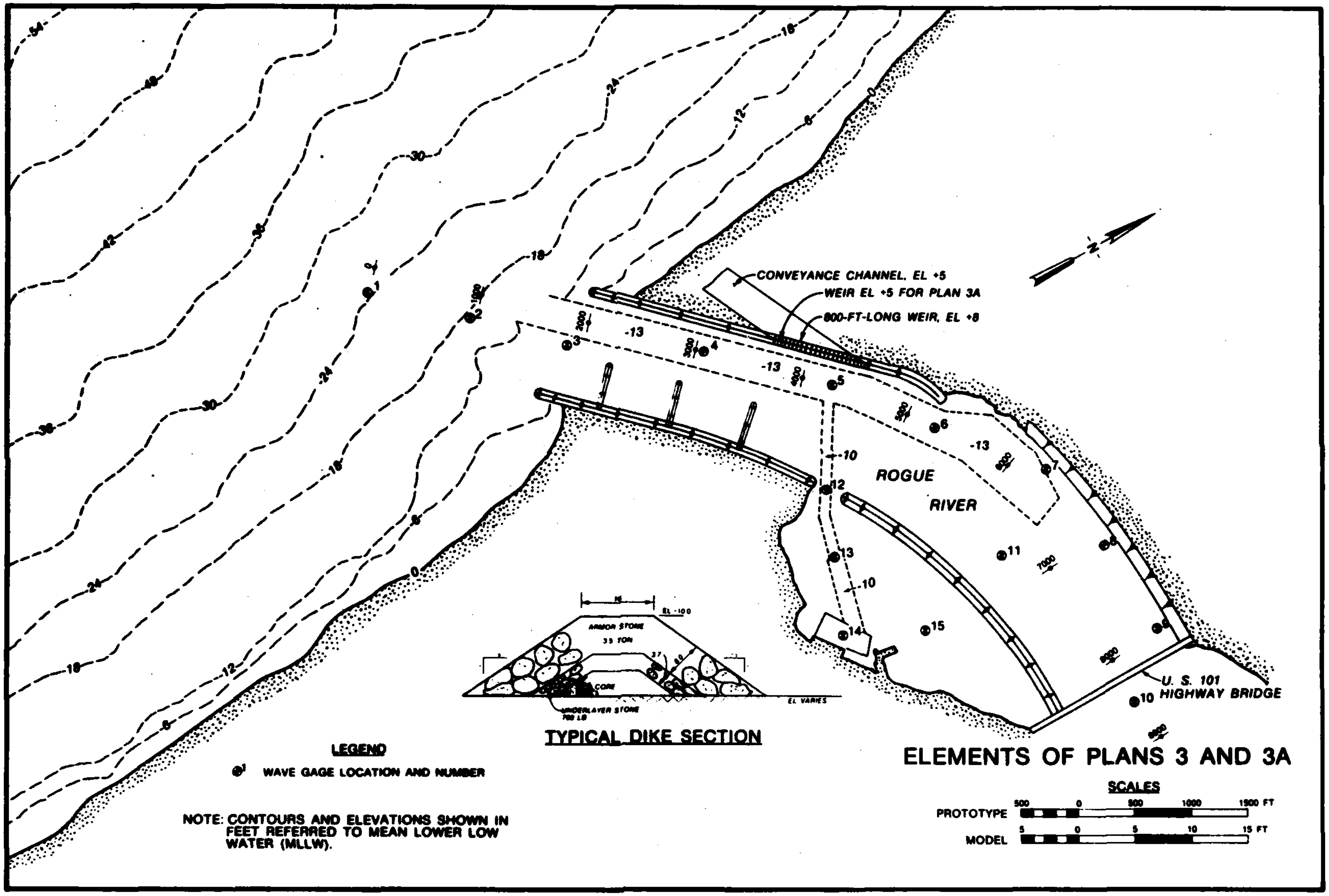

ROGUE
RIVER
U. S. 101
HIGHWAY BRIDGE
TYPICAL DIKE SECTION
ARMOR STONE
35 TON
CORE
UNDERLAYER STONE
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).
ELEMENTS OF PLAN 2
SCALES
PROTOTYPE
MODEL
1500 FT
15 FT

PLATE 4



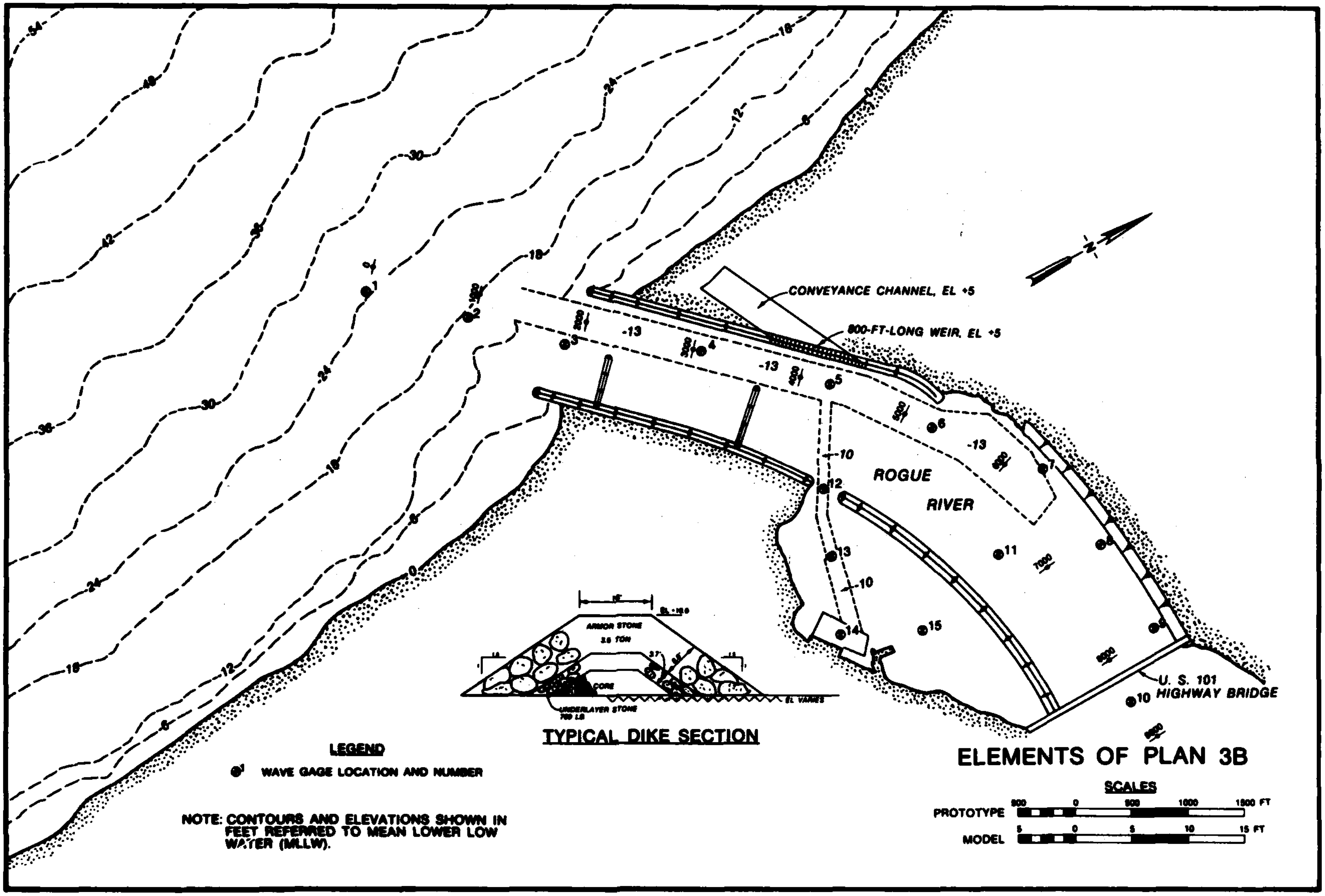
ROGUE
RIVER
U. S. 101
HIGHWAY BRIDGE
ARMOR STONE
3.9 TON
CORE
UNDERLAYER STONE
EL VARIES
TYPICAL DIKE SECTION
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).
ELEMENTS OF PLAN 2A
SCALES
PROTOTYPE
500 0 500 1000 1500 FT
MODEL
5 0 5 10 15 FT

PLATE 5

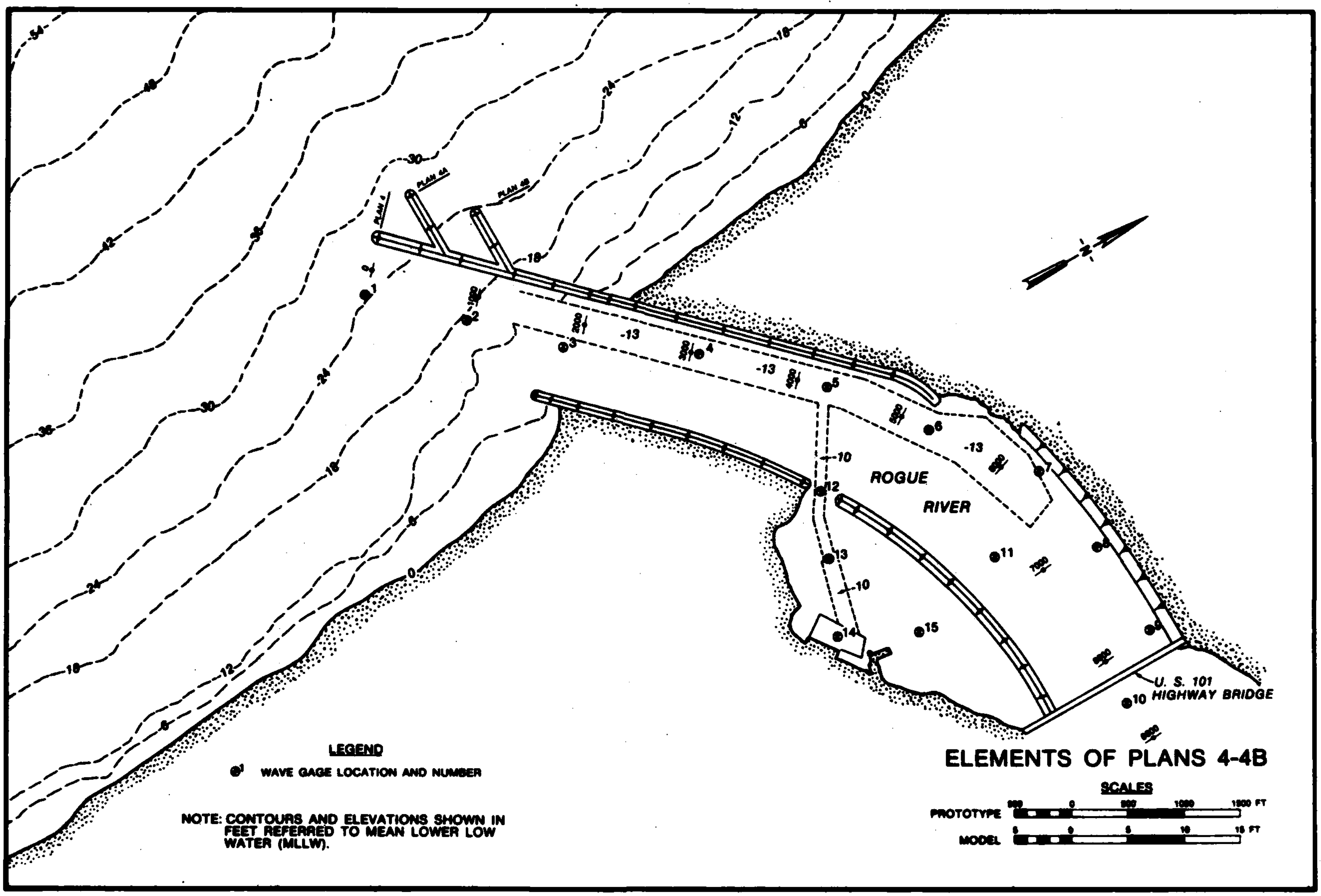


ELEMENTS OF PLANS 3 AND 3A

PLATE 6

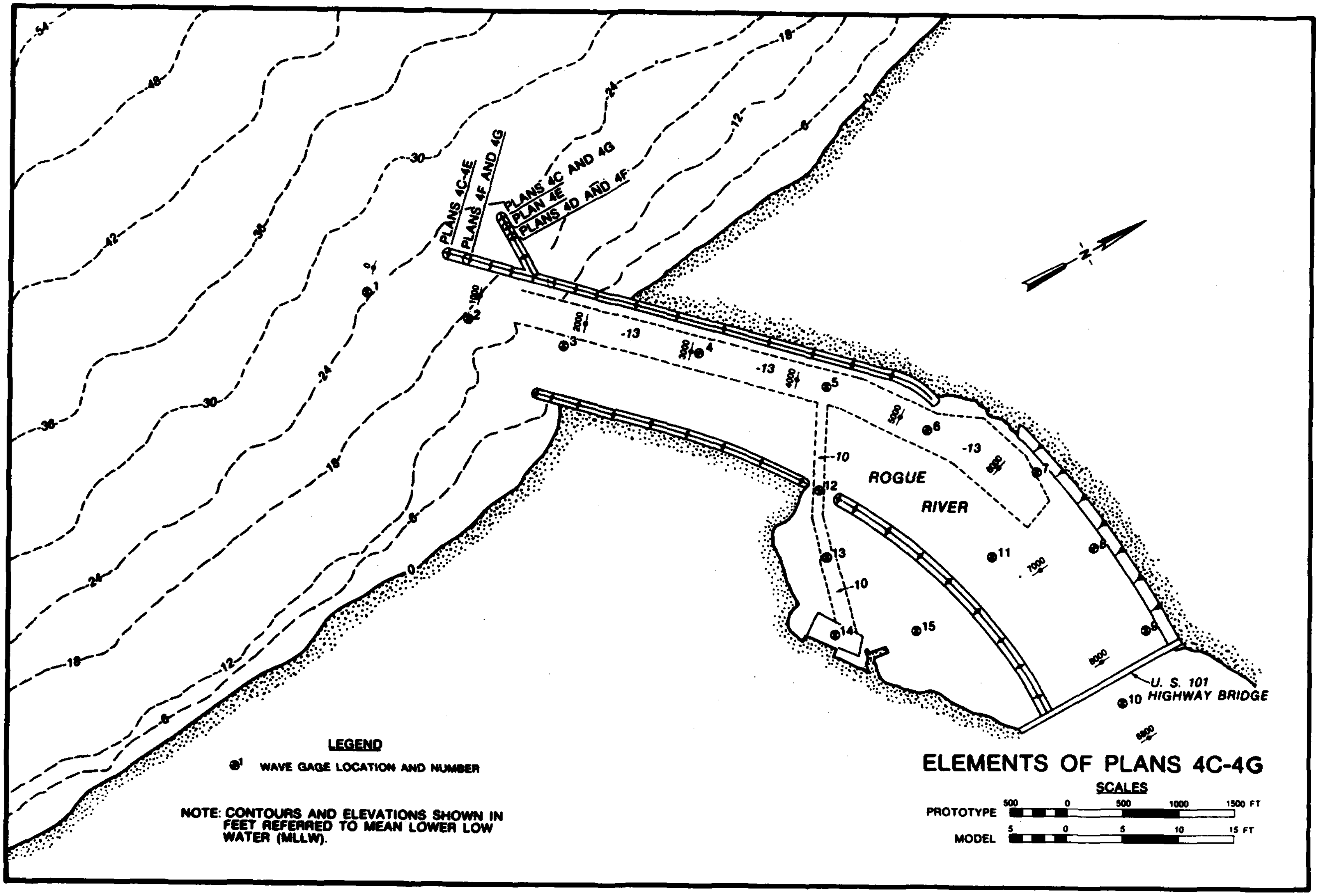


ELEMENTS OF PLAN 3B
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT
CONVEYANCE CHANNEL, EL +5
800-FT-LONG WEIR, EL +5
ROGUE
RIVER
U. S. 101
HIGHWAY BRIDGE
TYPICAL DIKE SECTION
ARMOR STONE
3.5 TON
CORE
UNDERLAYER STONE
700 LB
EL VARIES
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).



ELEMENTS OF PLANS 4-4B

PLATE 8


PLANS 4C-4E
PLANS 4F AND 4G
PLANS 4C AND 4G
PLAN 4E
PLANS 4D AND 4F
ROGUE
RIVER
U. S. 101
HIGHWAY BRIDGE
N
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).
ELEMENTS OF PLANS 4C-4G
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT

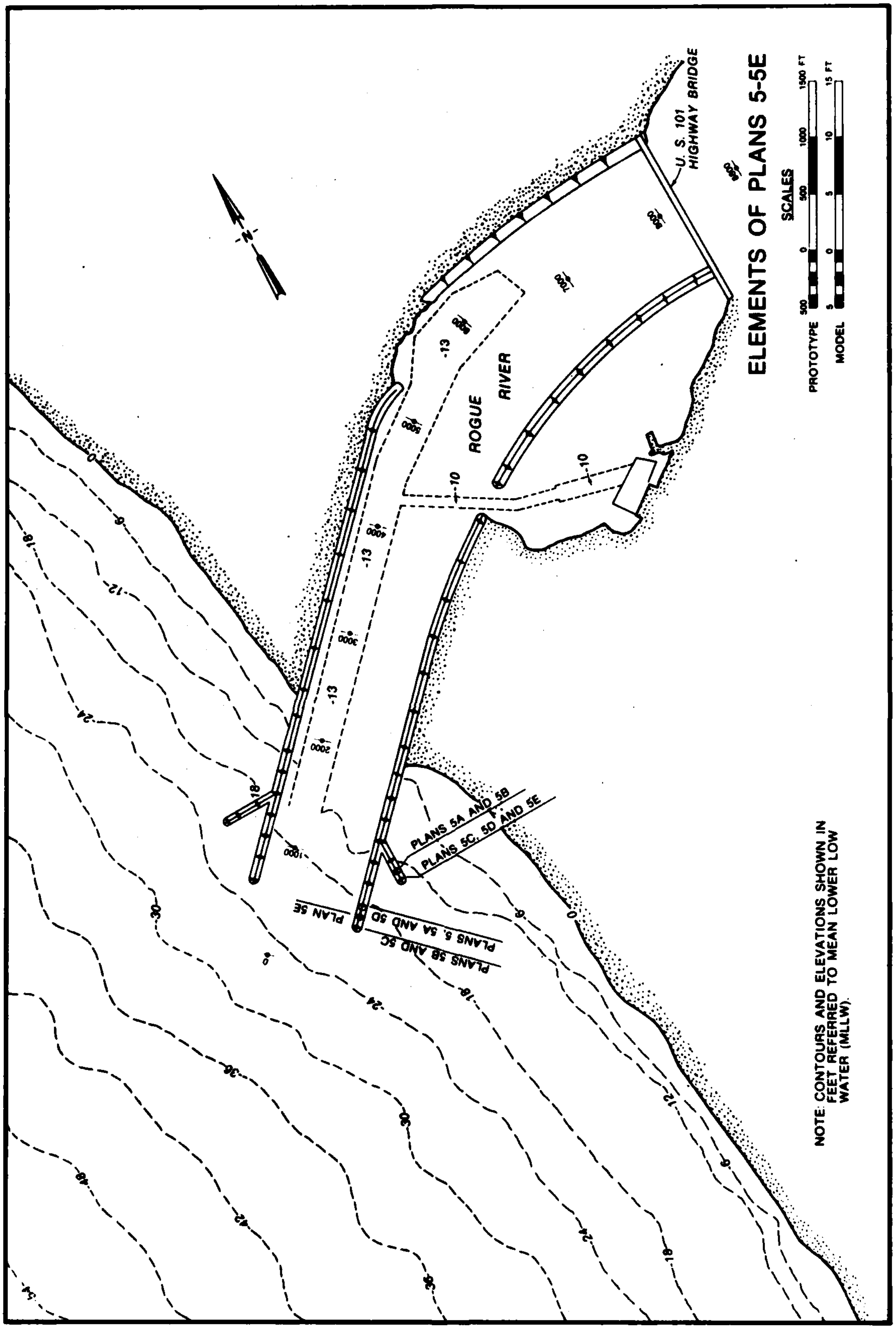
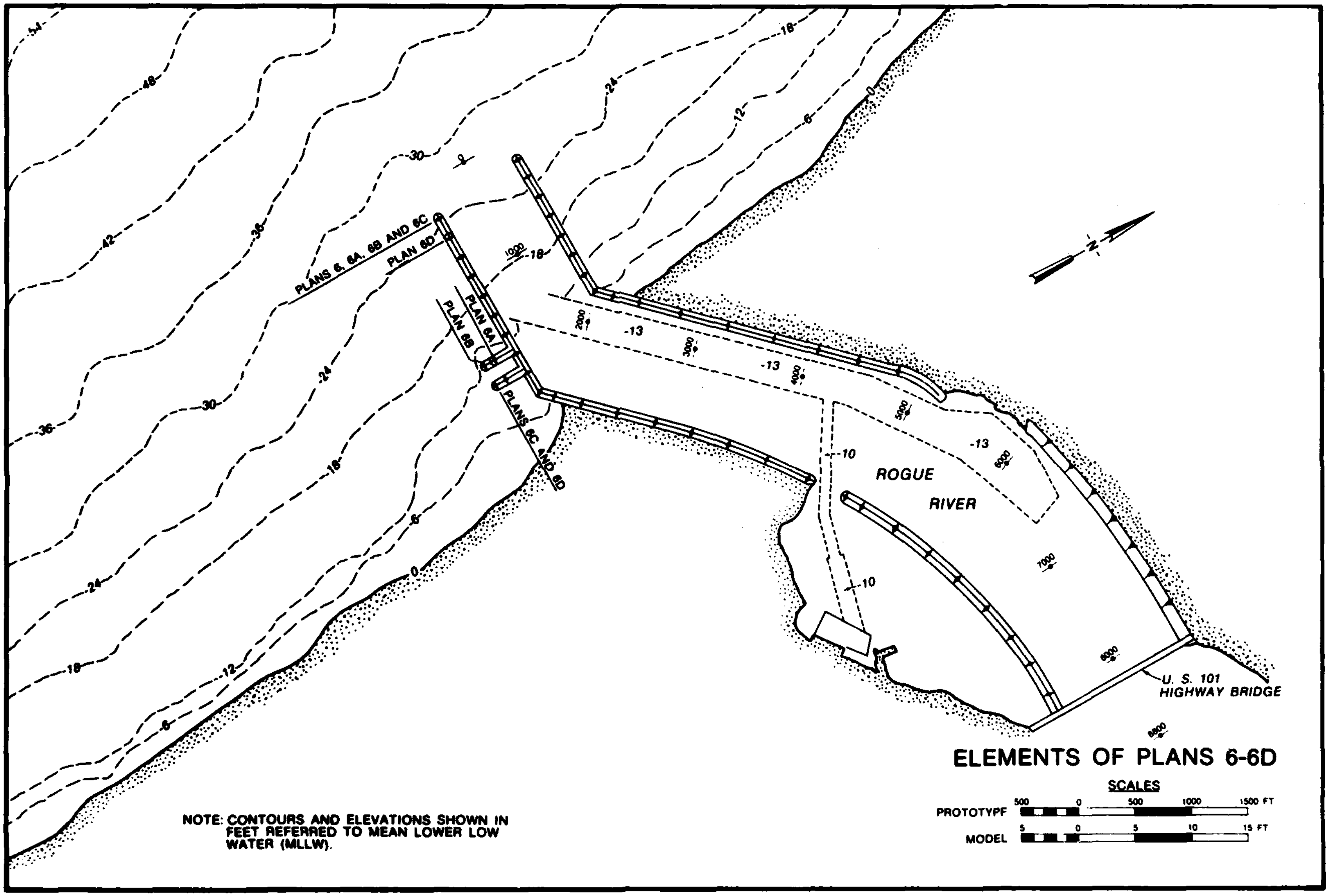

ELEMENTS OF PLANS 5-5E
SCALES
PROTOTYPE
MODEL
500 0 500 1000 1500 FT
5 0 5 10 15 FT
U. S. 101 HIGHWAY BRIDGE
ROGUE
RIVER
PLANS 5A AND 5B
PLANS 5C, 5D AND 5E
PLAN 5E
PLANS 5, 5A AND 5D
PLANS 5B AND 5C
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

PLATE 10


ELEMENTS OF PLANS 6-6D
SCALES
PROTOTYPF
MODEL
500 0 500 1000 1500 FT
5 0 5 10 15 FT
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).
ROGUE
RIVER
U. S. 101
HIGHWAY BRIDGE
PLANS 6, 6A, 6B AND 6C
PLAN 6D
PLAN 6A
PLAN 6B
PLANS 6C AND 6D
N
-13
-10
1000
2000
3000
4000
5000
6000
7000
8000

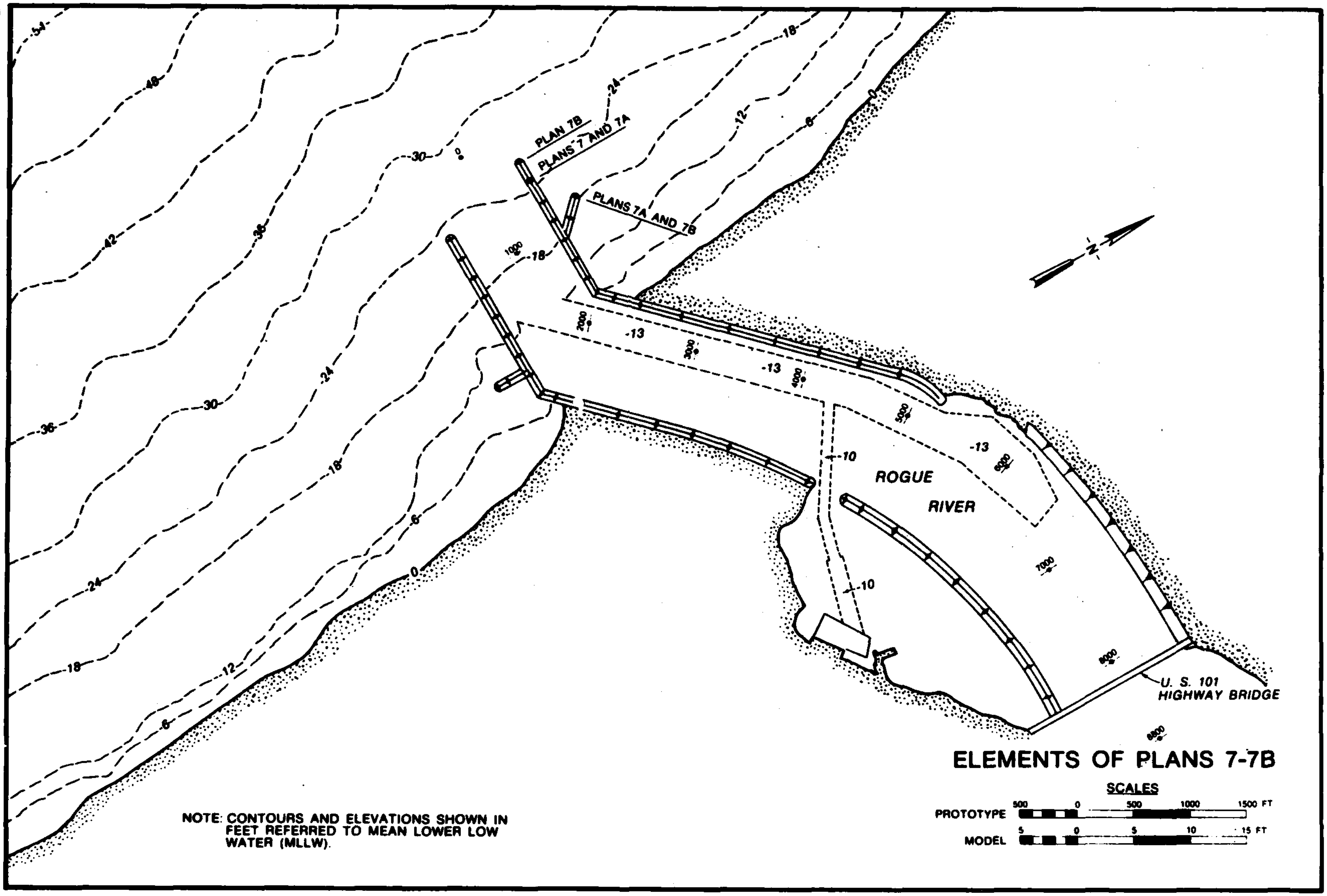
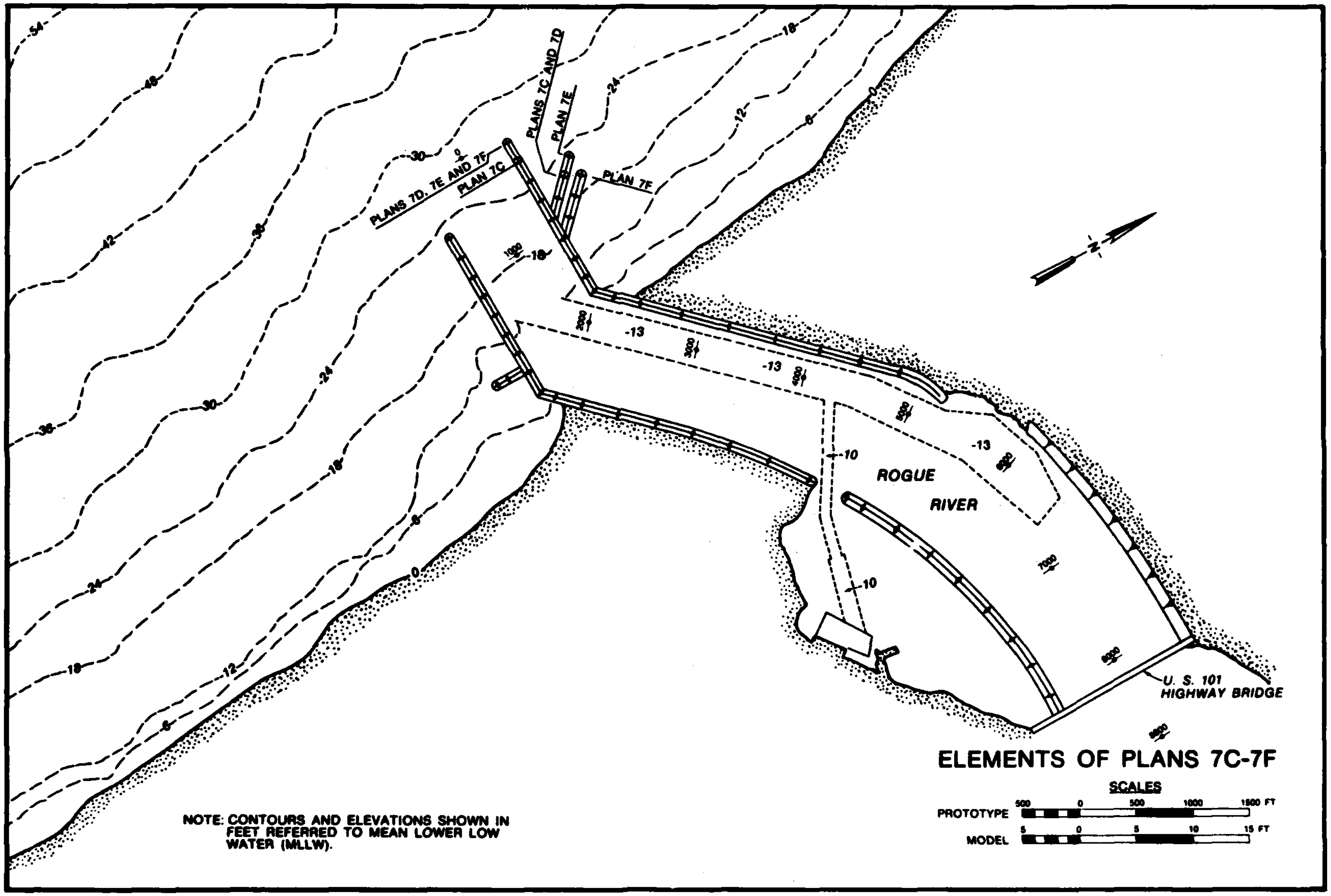
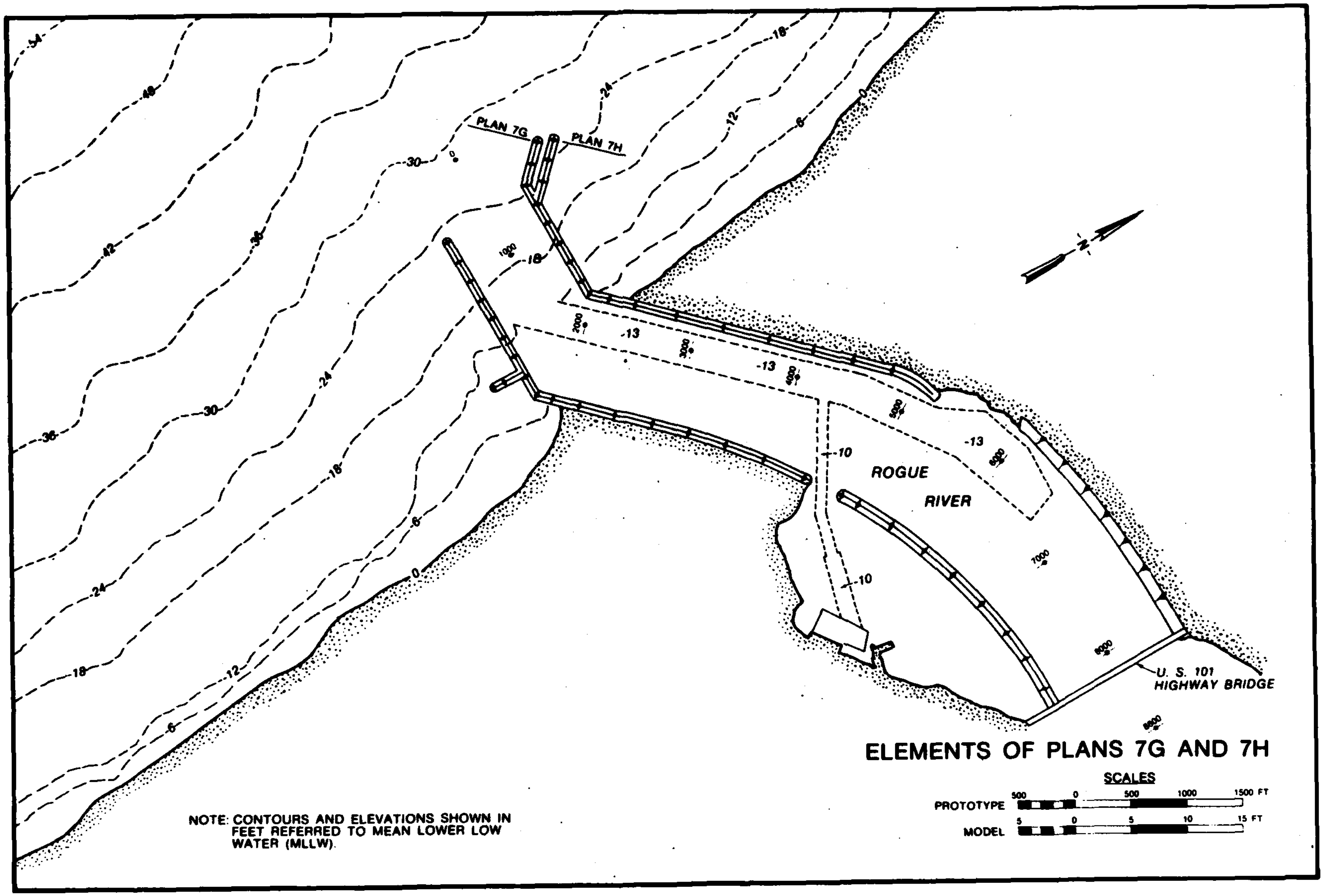

PLAN 7B
PLANS 7 AND 7A
PLANS 7A AND 7B
N
ROGUE
RIVER
-13
-10
U. S. 101
HIGHWAY BRIDGE
ELEMENTS OF PLANS 7-7B
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

PLATE 12



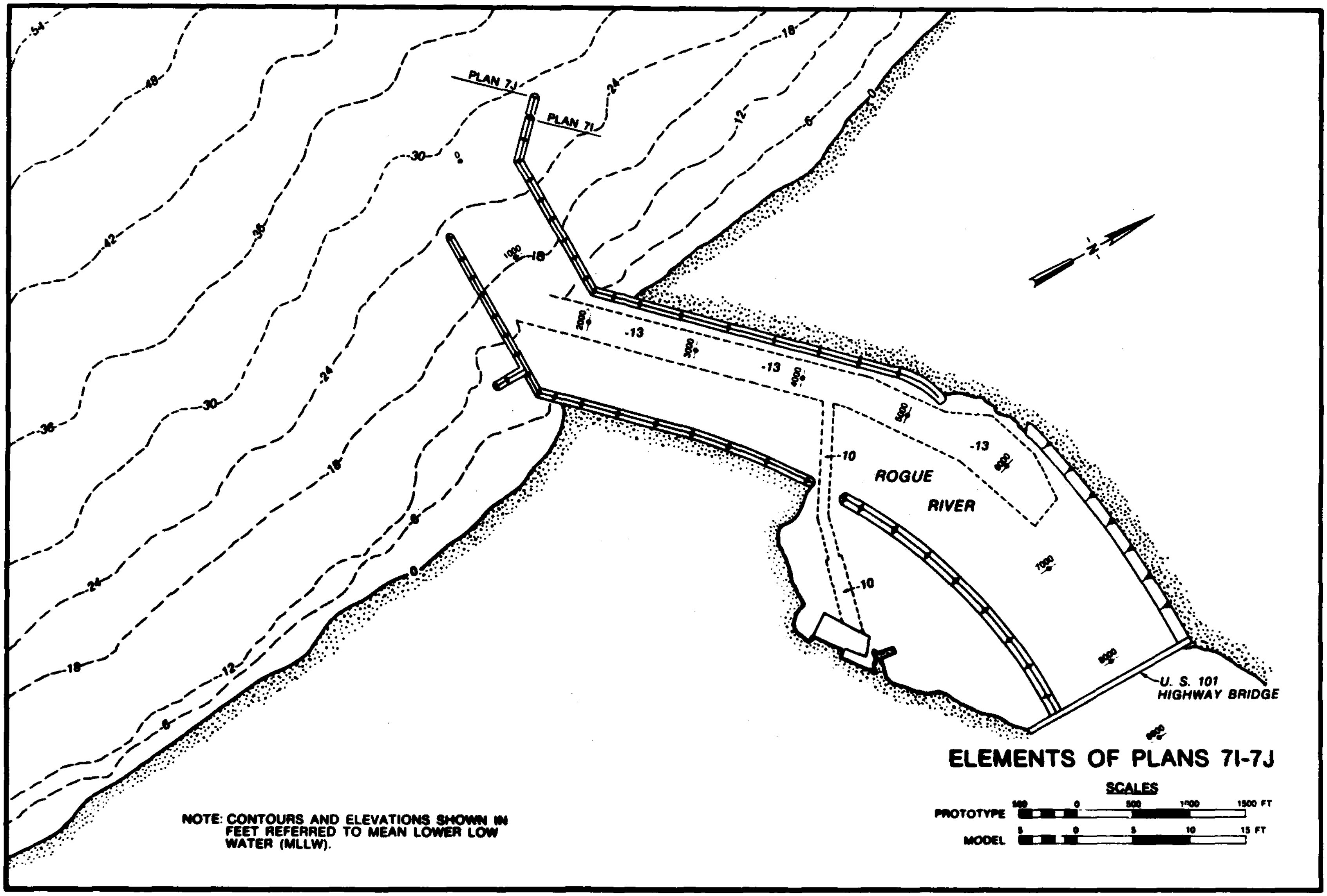
ELEMENTS OF PLANS 7C-7F

NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).



ELEMENTS OF PLANS 7G AND 7H

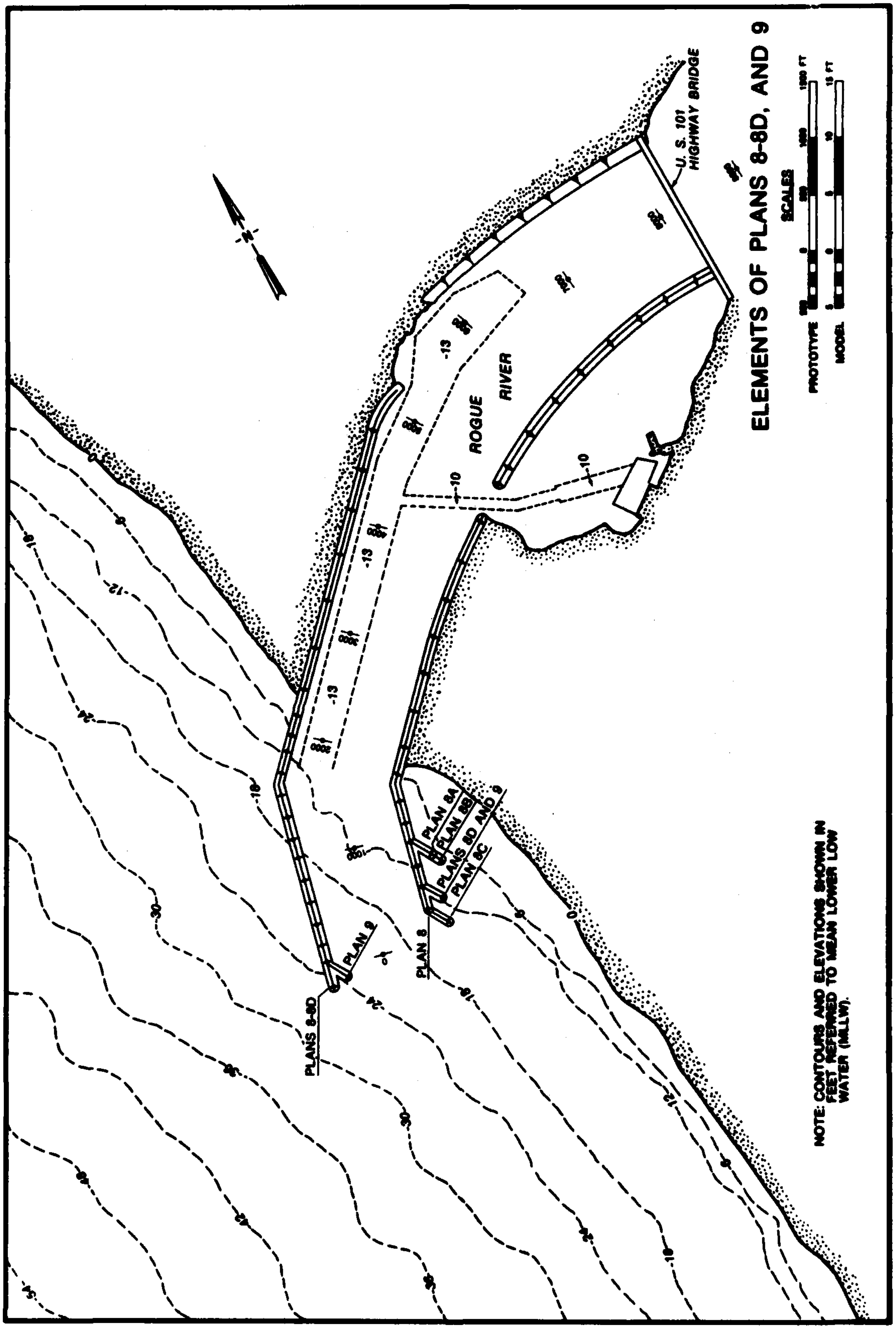
PLATE 14



ELEMENTS OF PLANS 7I-7J

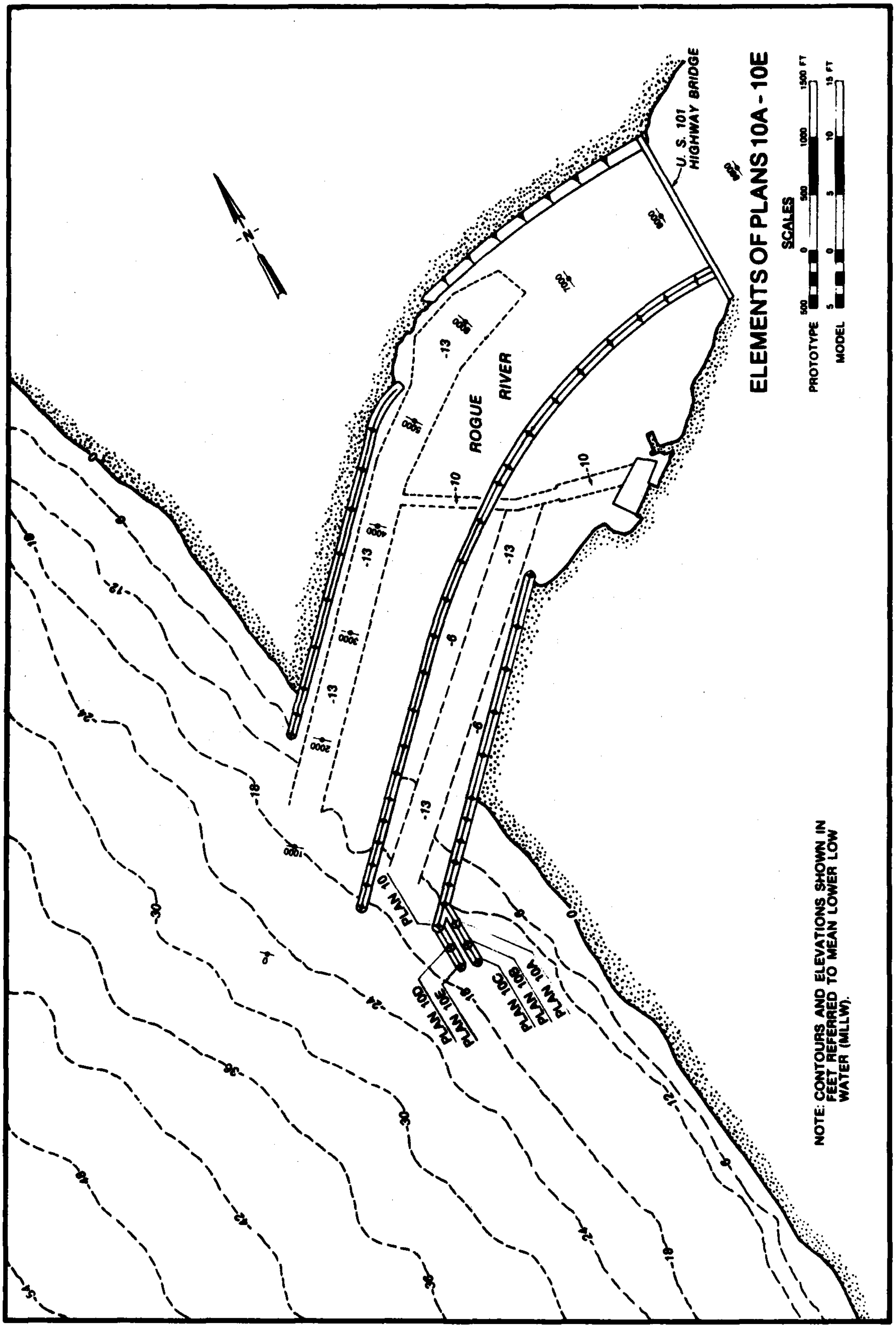
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

PLATE 15



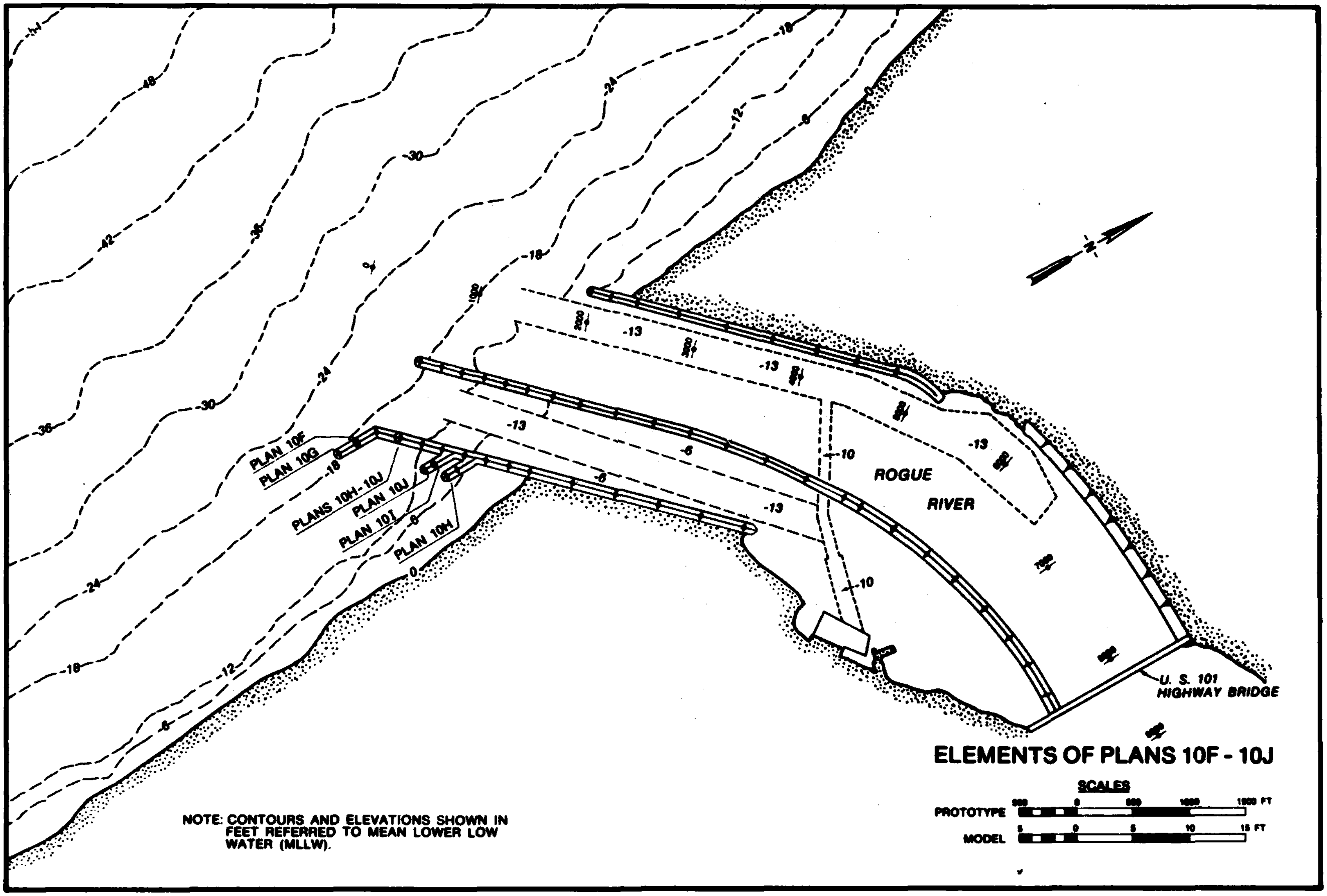
ELEMENTS OF PLANS 8-8D, AND 9

PLATE 16



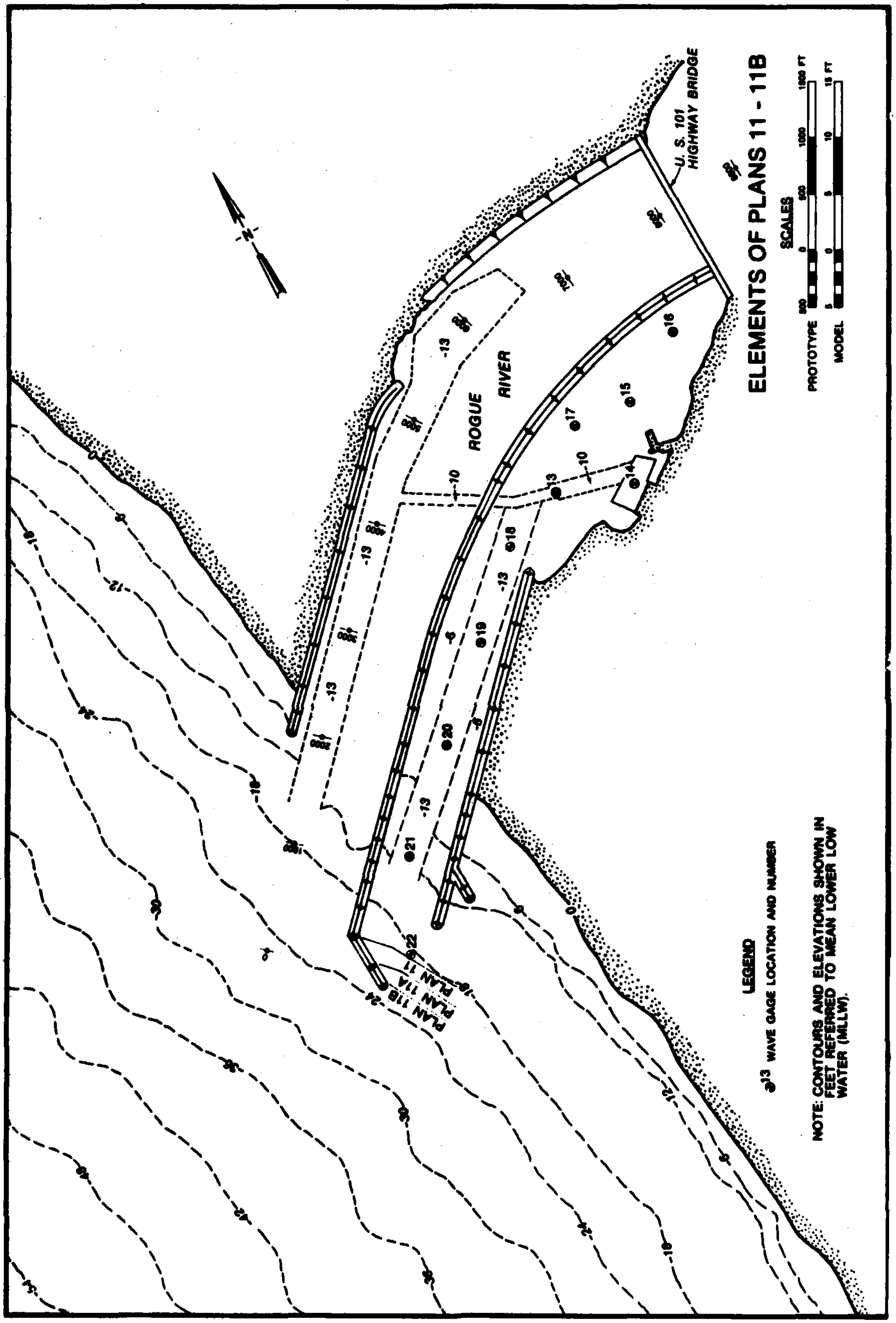
ELEMENTS OF PLANS 10A - 10E
SCALES
PROTOTYPE
MODEL
500 0 500 1000 1500 FT
5 0 5 10 15 FT
U. S. 101 HIGHWAY BRIDGE
ROGUE
RIVER
N
PLAN 10
PLAN 10A
PLAN 10B
PLAN 10C
PLAN 10D
PLAN 10E
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

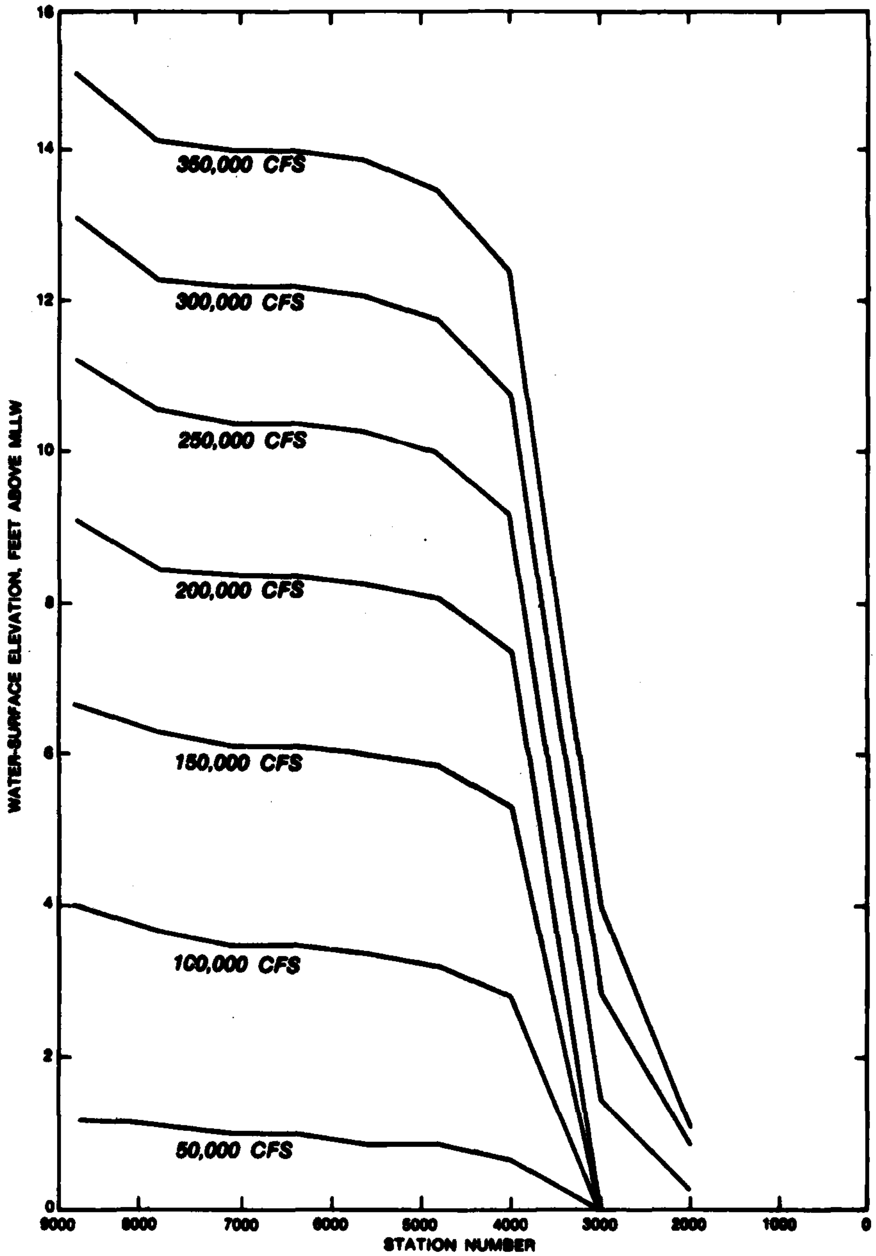
PLATE 17



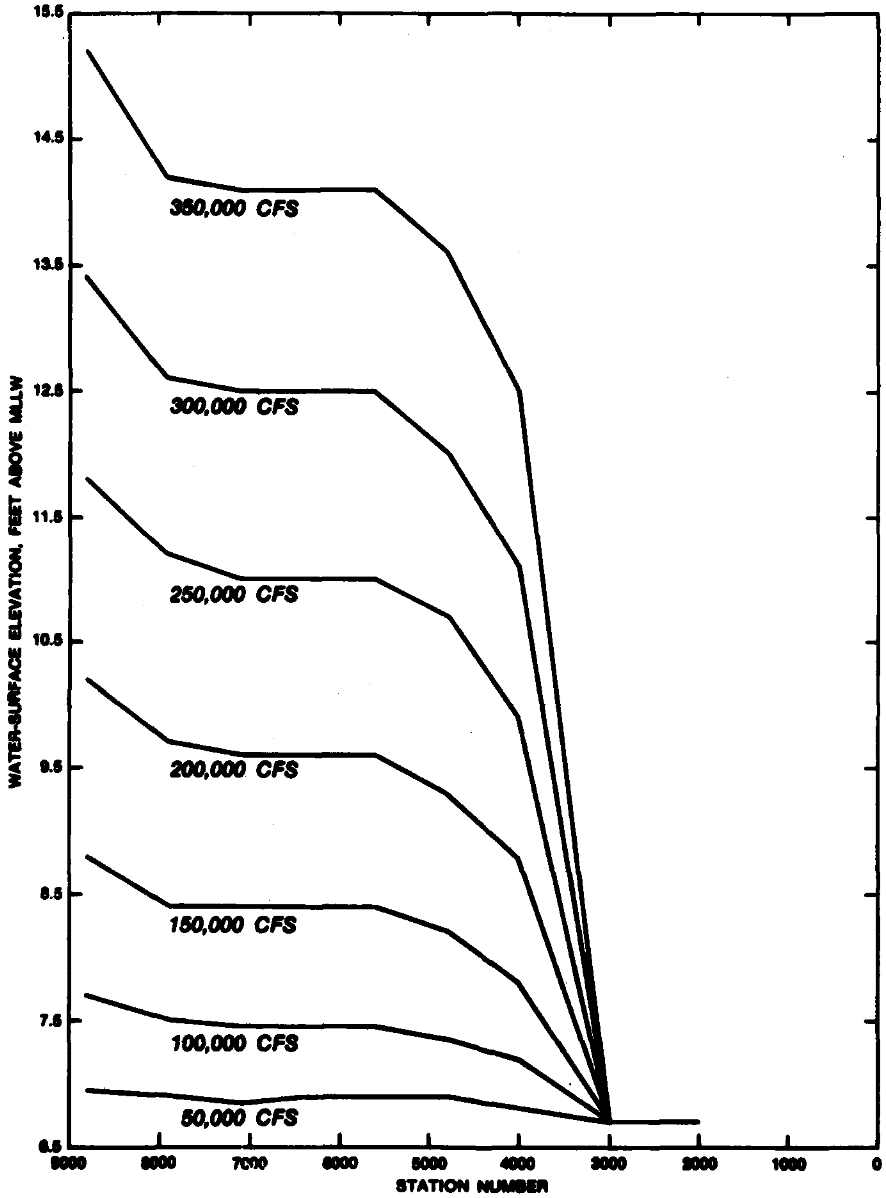
ELEMENTS OF PLANS 10F - 10J

PLATE 18

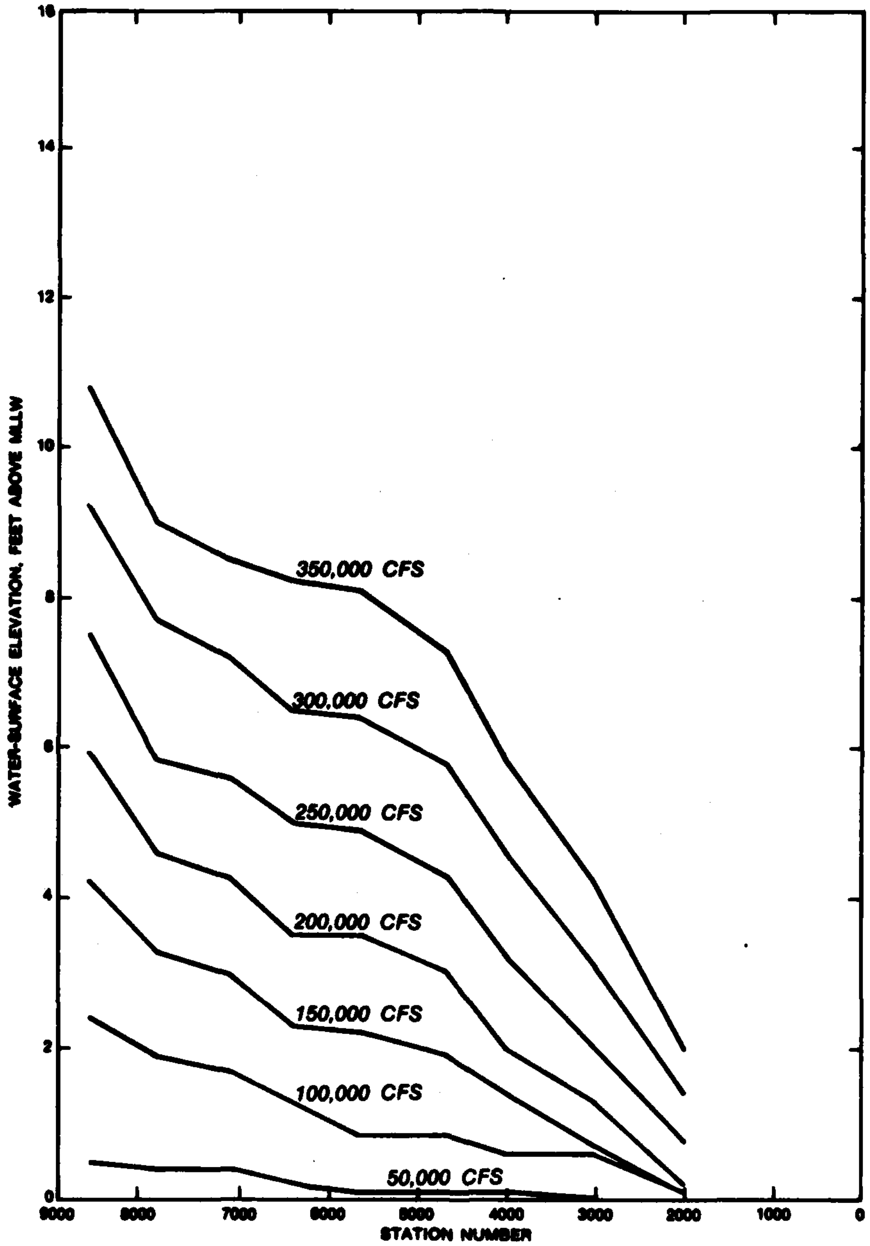

ELEMENTS OF PLANS 11 - 11B
SCALES
PROTOTYPE 500 0 500 1000 1500 FT
MODEL 5 0 5 10 15 FT
U. S. 101 HIGHWAY BRIDGE
ROGUE RIVER
PLAN 11
PLAN 11A
PLAN 11B
LEGEND
13 WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).



WATER-SURFACE PROFILES
BASE TEST 1
SWL = 0.0 FT

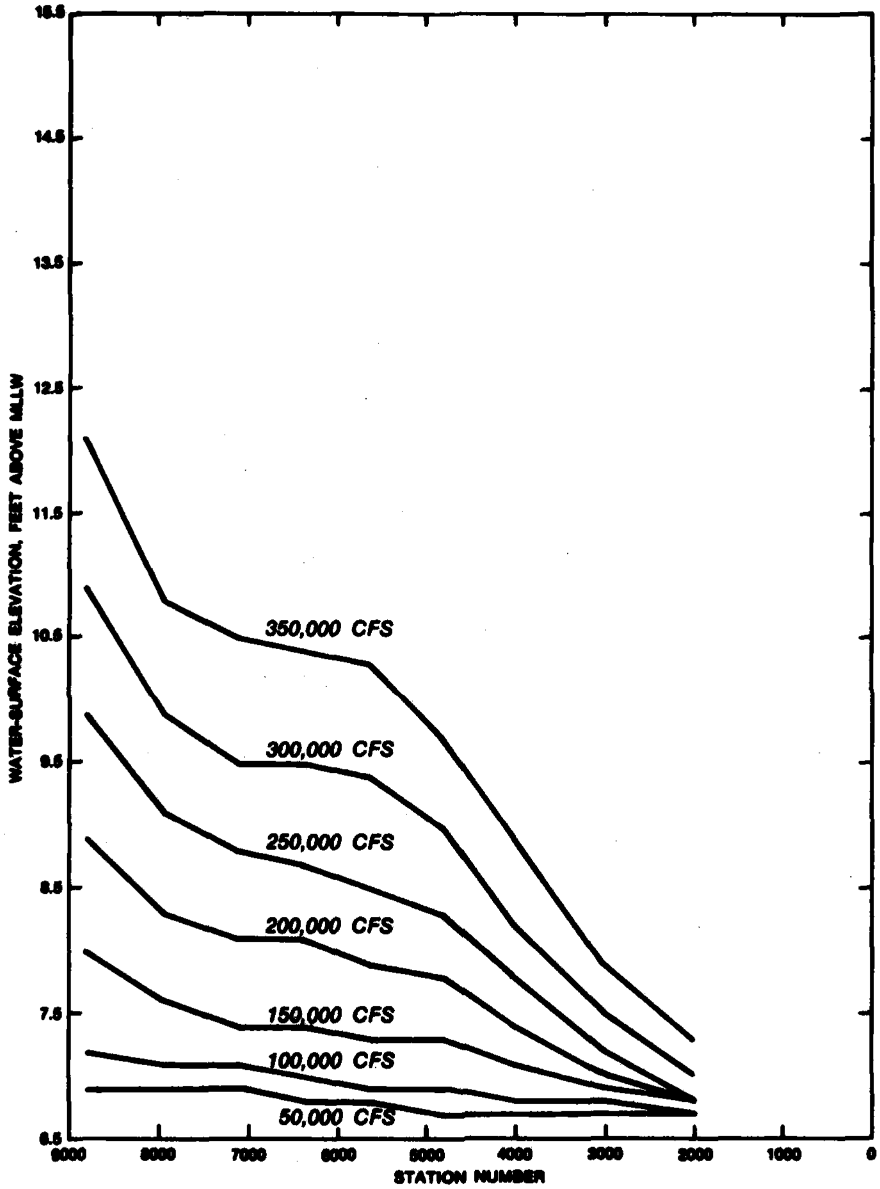


WATER-SURFACE PROFILES
BASE TESTS 1
SWL = + 6.7 FT

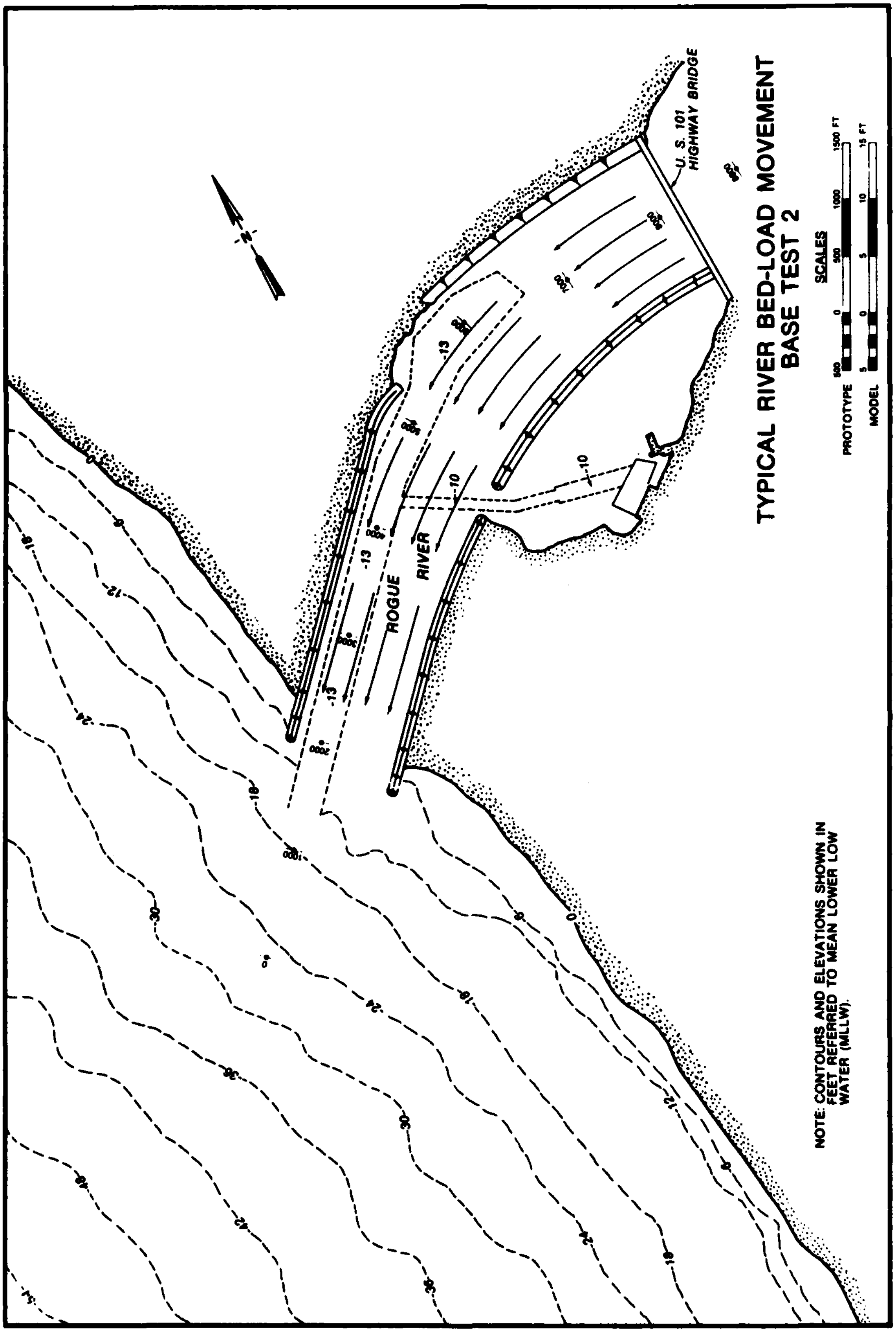


WATER-SURFACE PROFILES
BASE TEST 2
SWL = 0.0 FT

PLATE 22

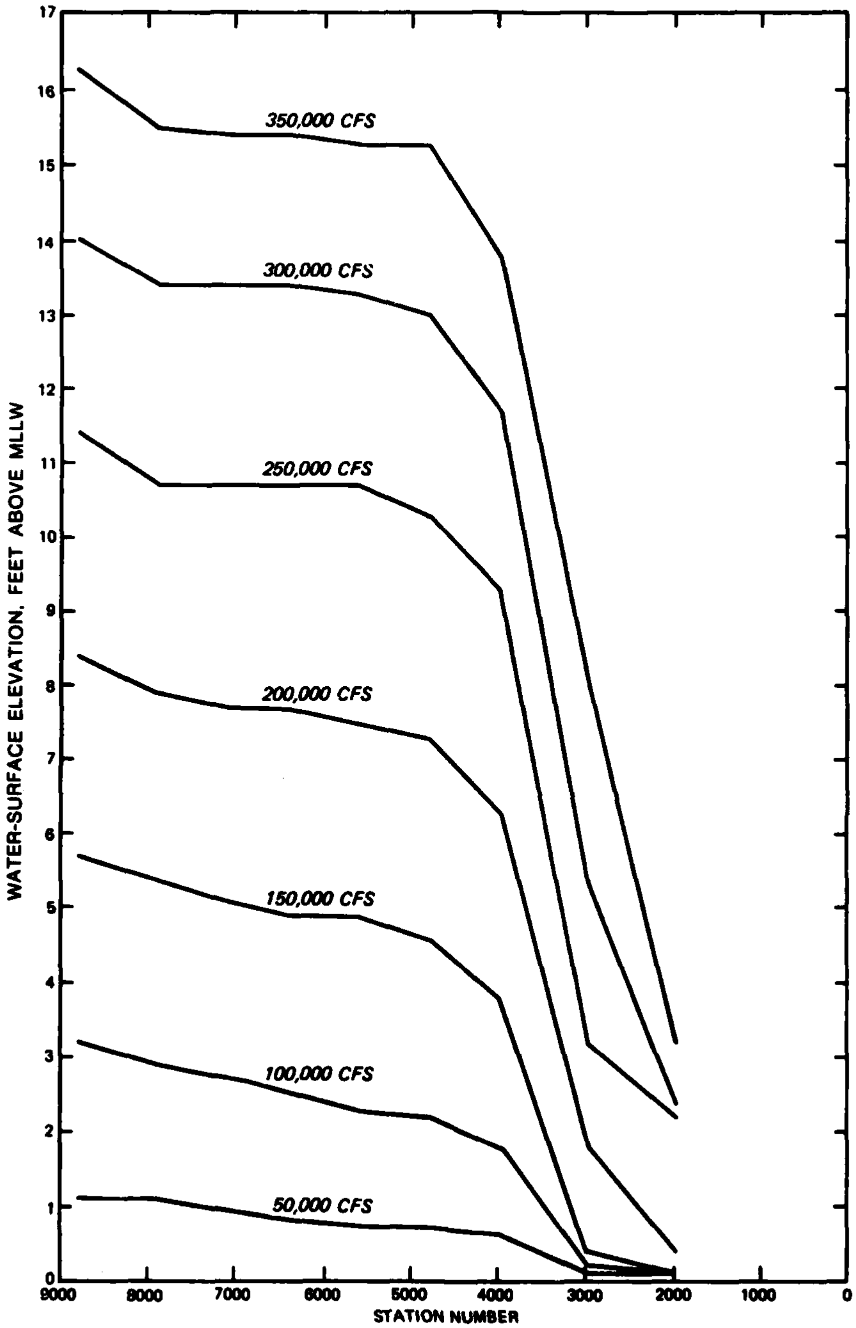


WATER-SURFACE PROFILES
BASE TEST 2
SWL = + 6.7 FT

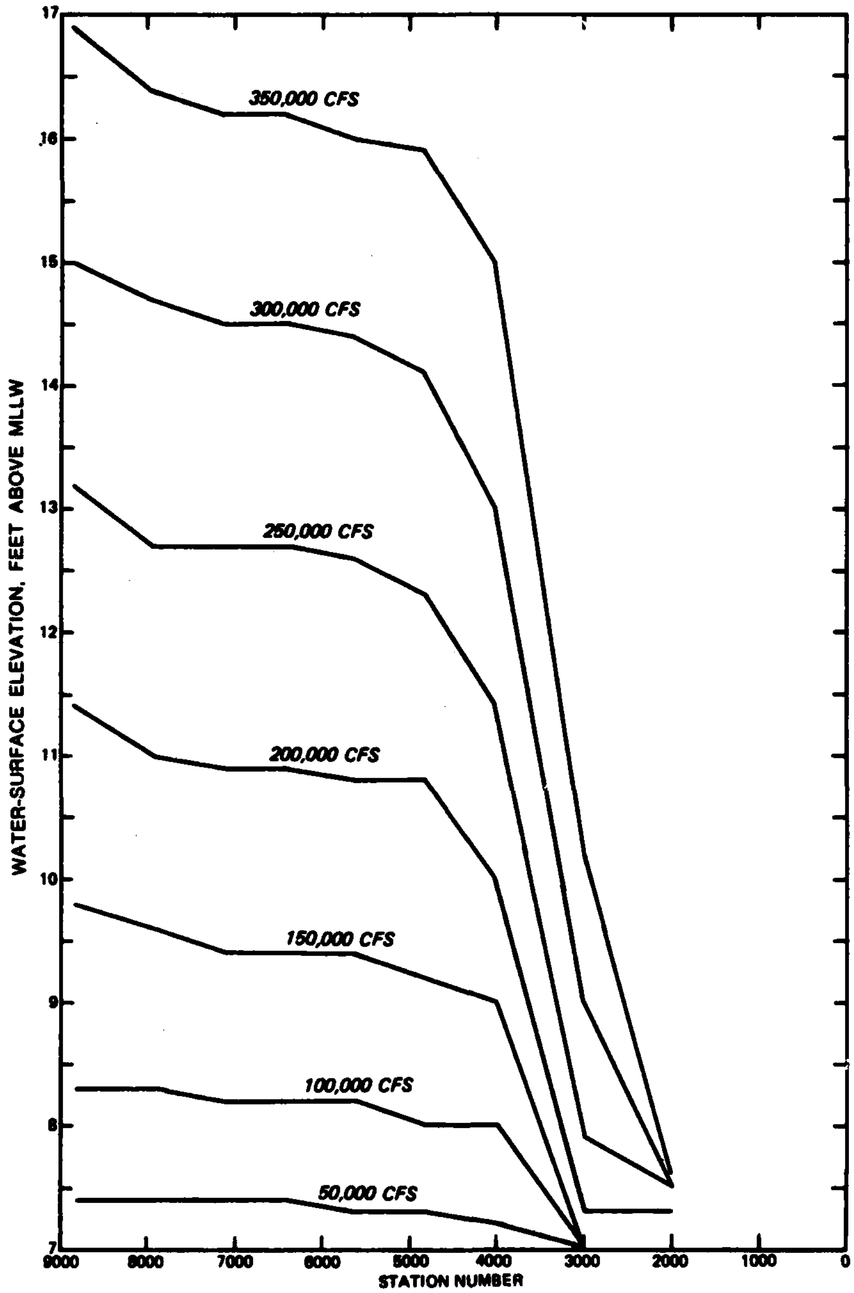


TYPICAL RIVER BED-LOAD MOVEMENT
BASE TEST 2

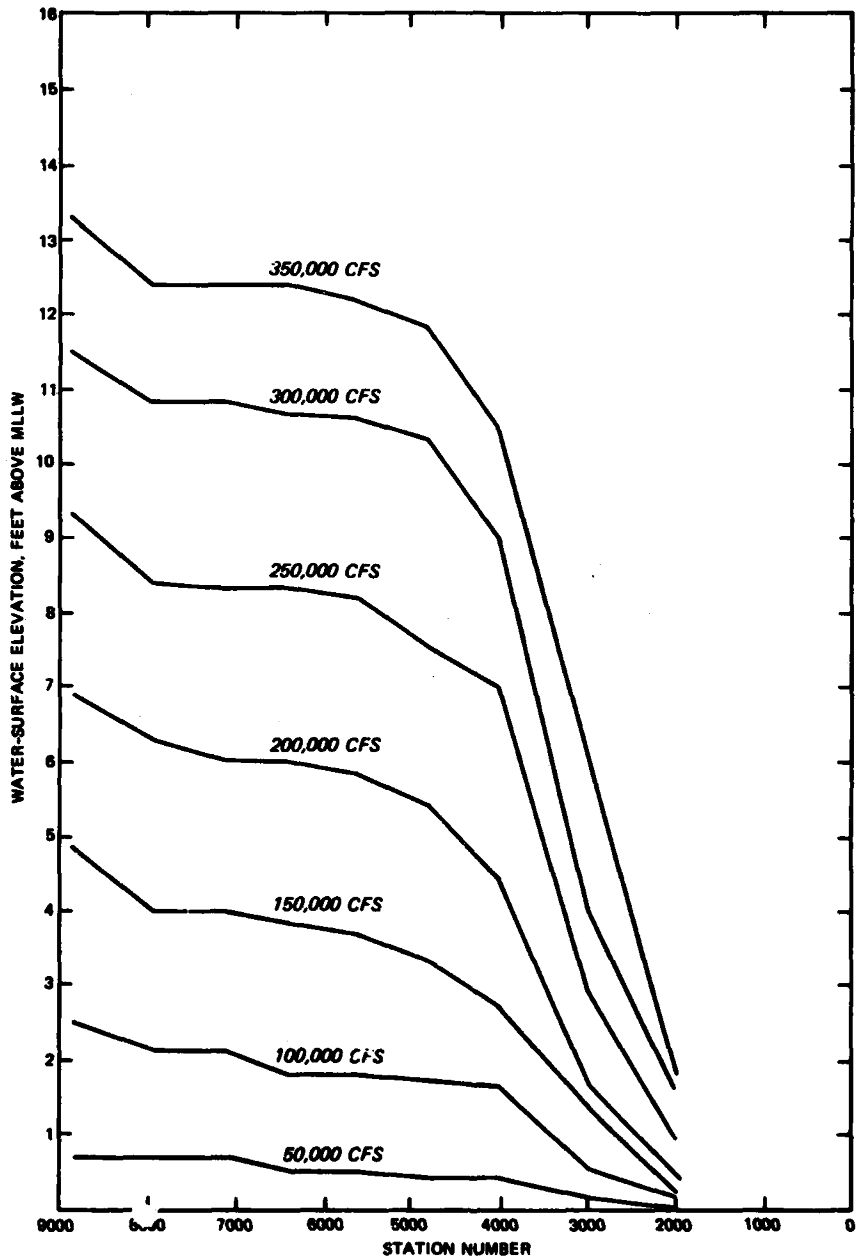
PLATE 24



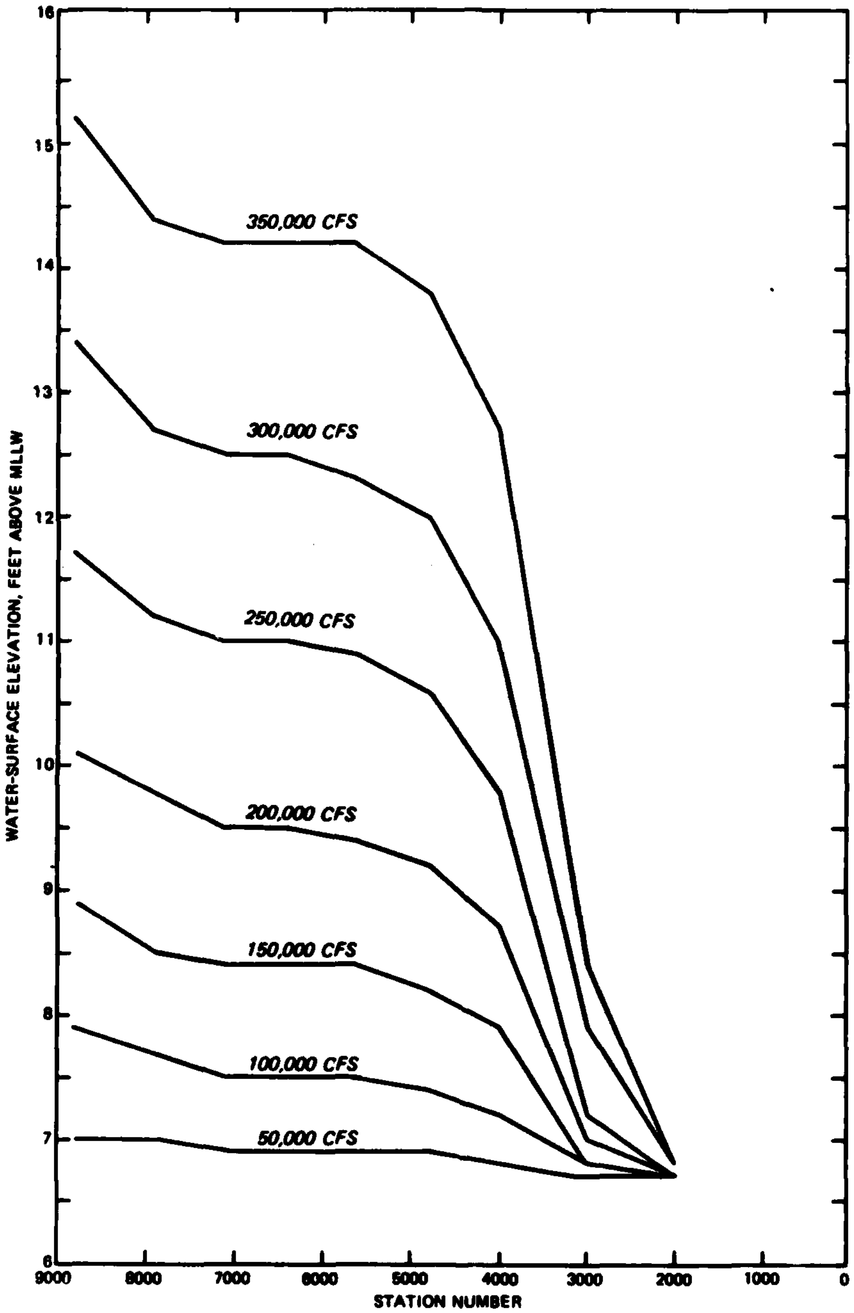
WATER-SURFACE PROFILES
PLAN 2
SWL = 0.0 FT



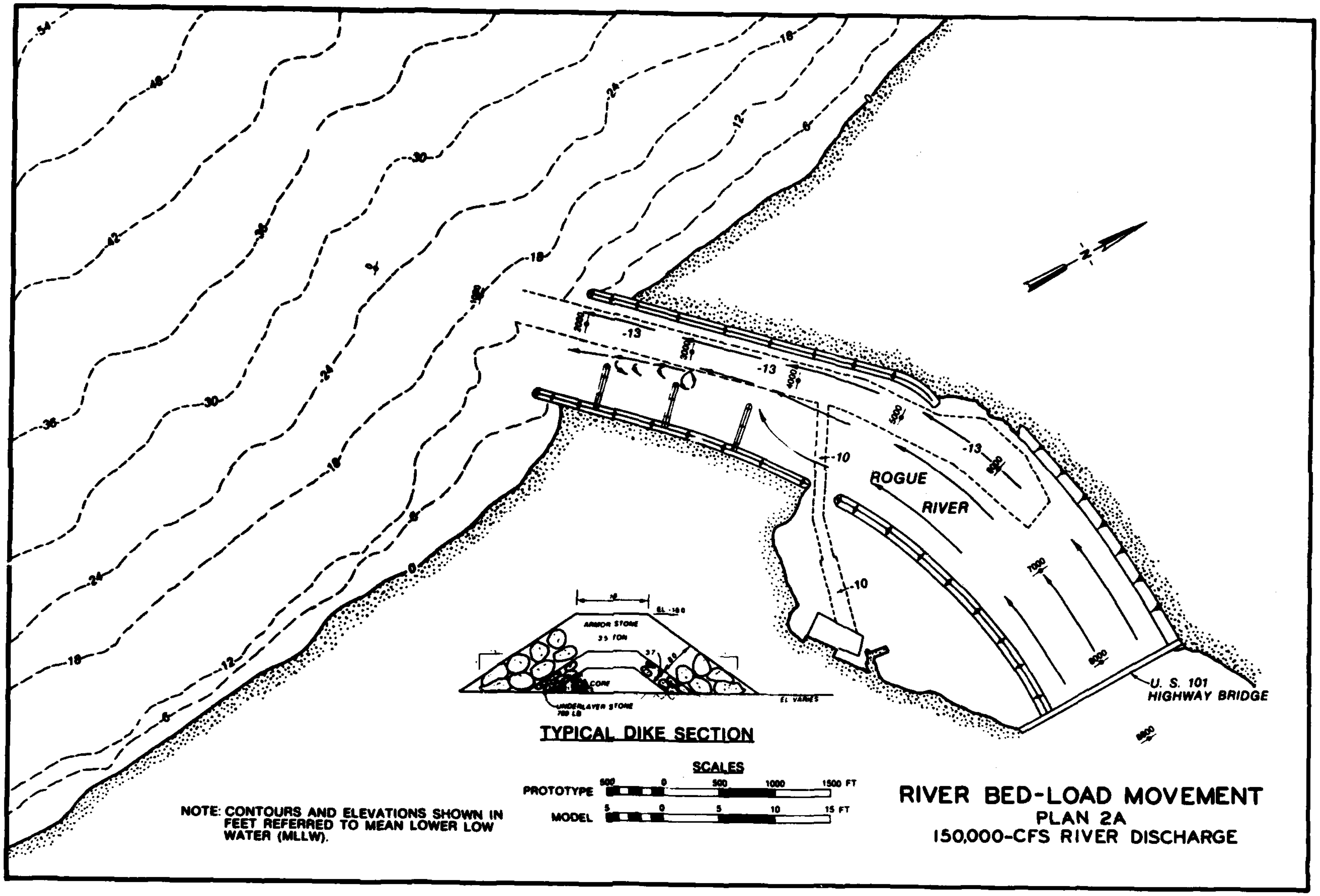
WATER-SURFACE PROFILES
PLAN 2
SWL = +6.7 FT



WATER-SURFACE PROFILES
PLAN 2A
SWL = 0.0 FT



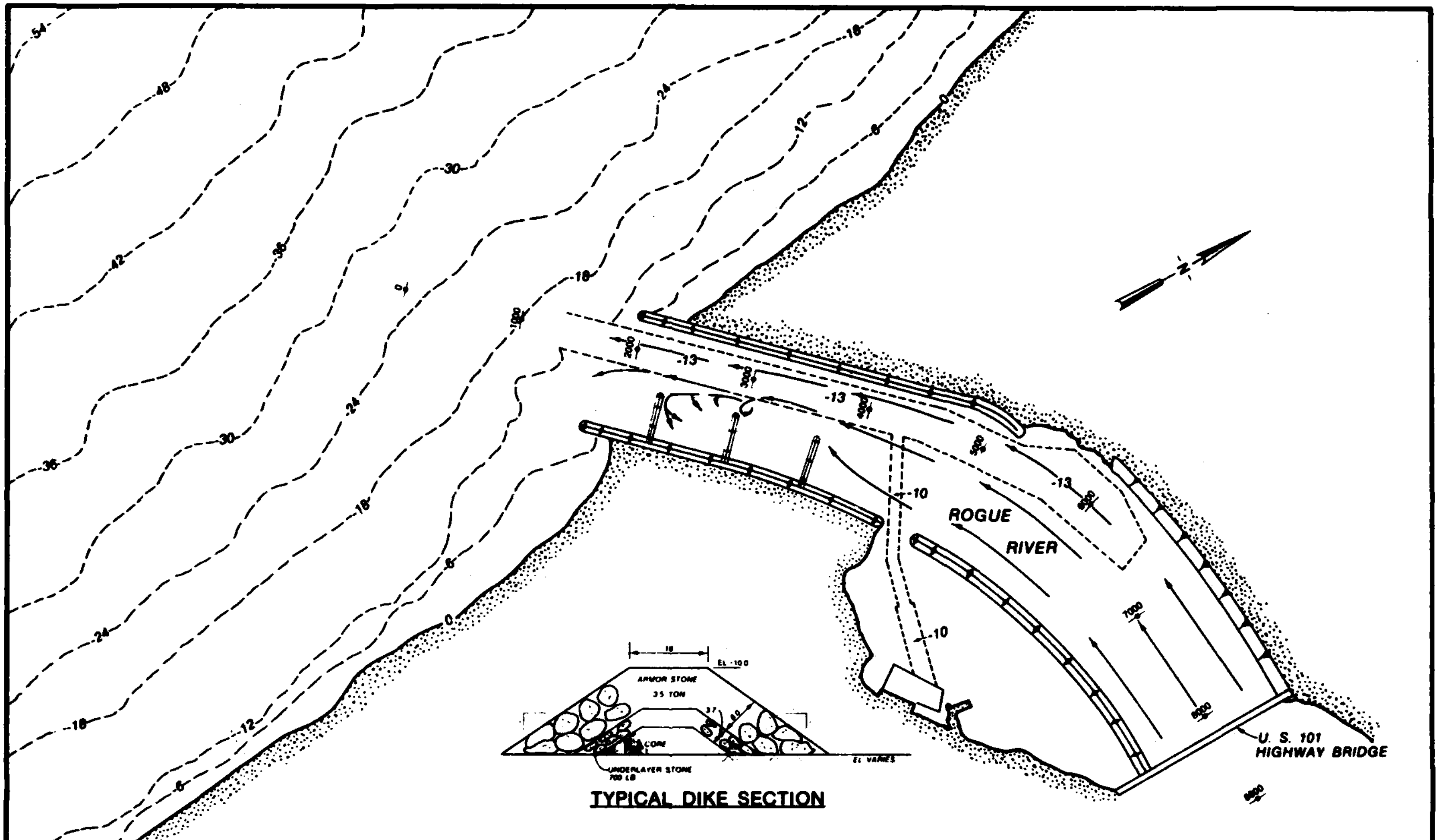
WATER-SURFACE PROFILES
PLAN 2A
SWL = + 6.7 FT



RIVER BED-LOAD MOVEMENT
PLAN 2A
150,000-CFS RIVER DISCHARGE

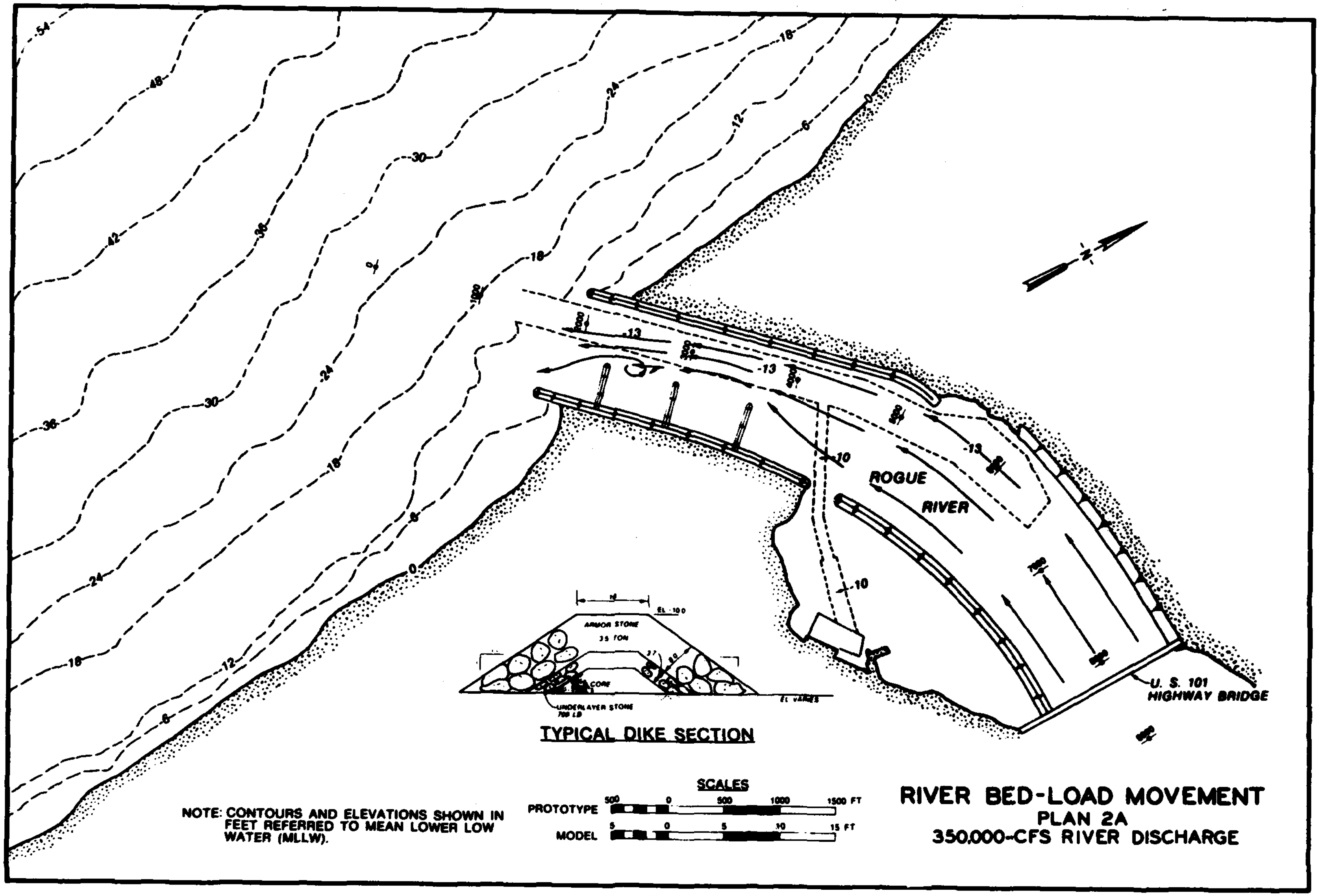
NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

PLATE 29



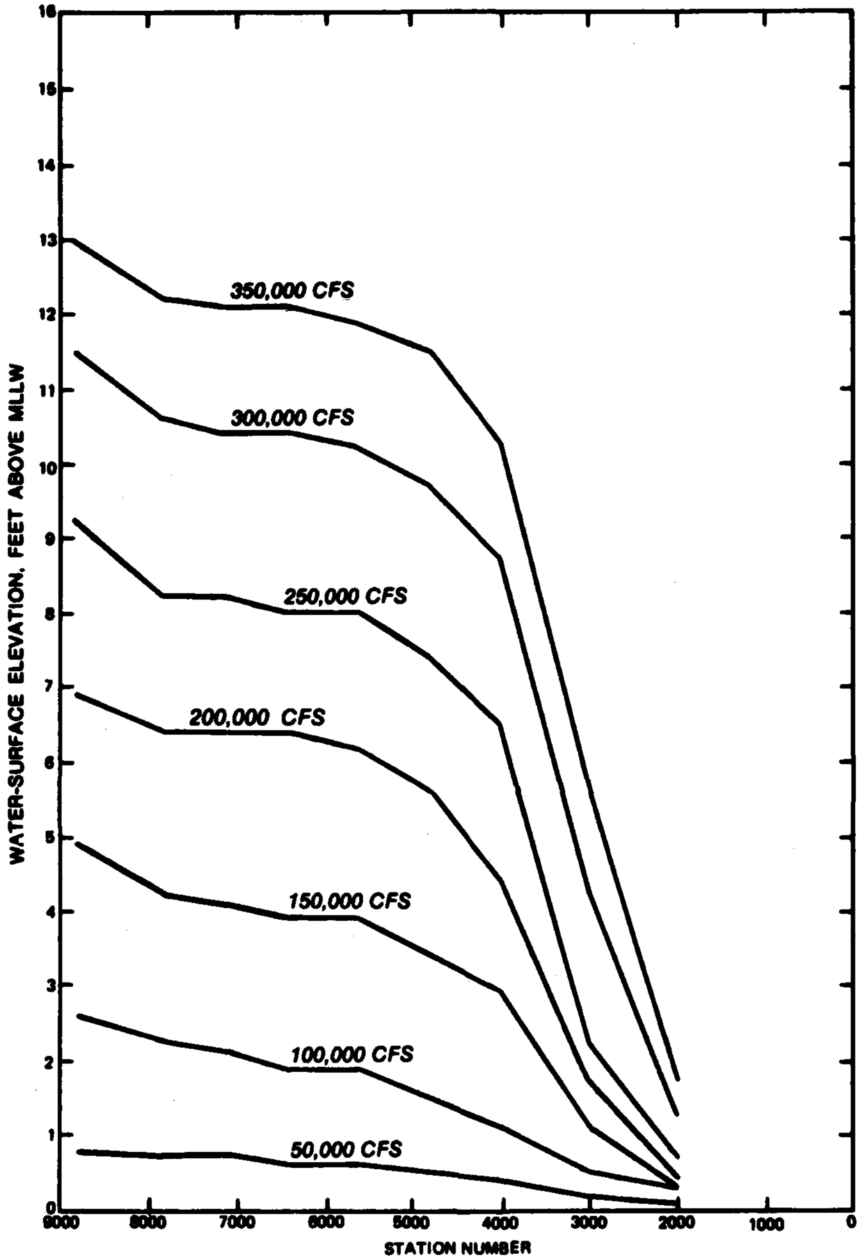
RIVER BED-LOAD MOVEMENT
PLAN 2A
250,000-CFS RIVER DISCHARGE

NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

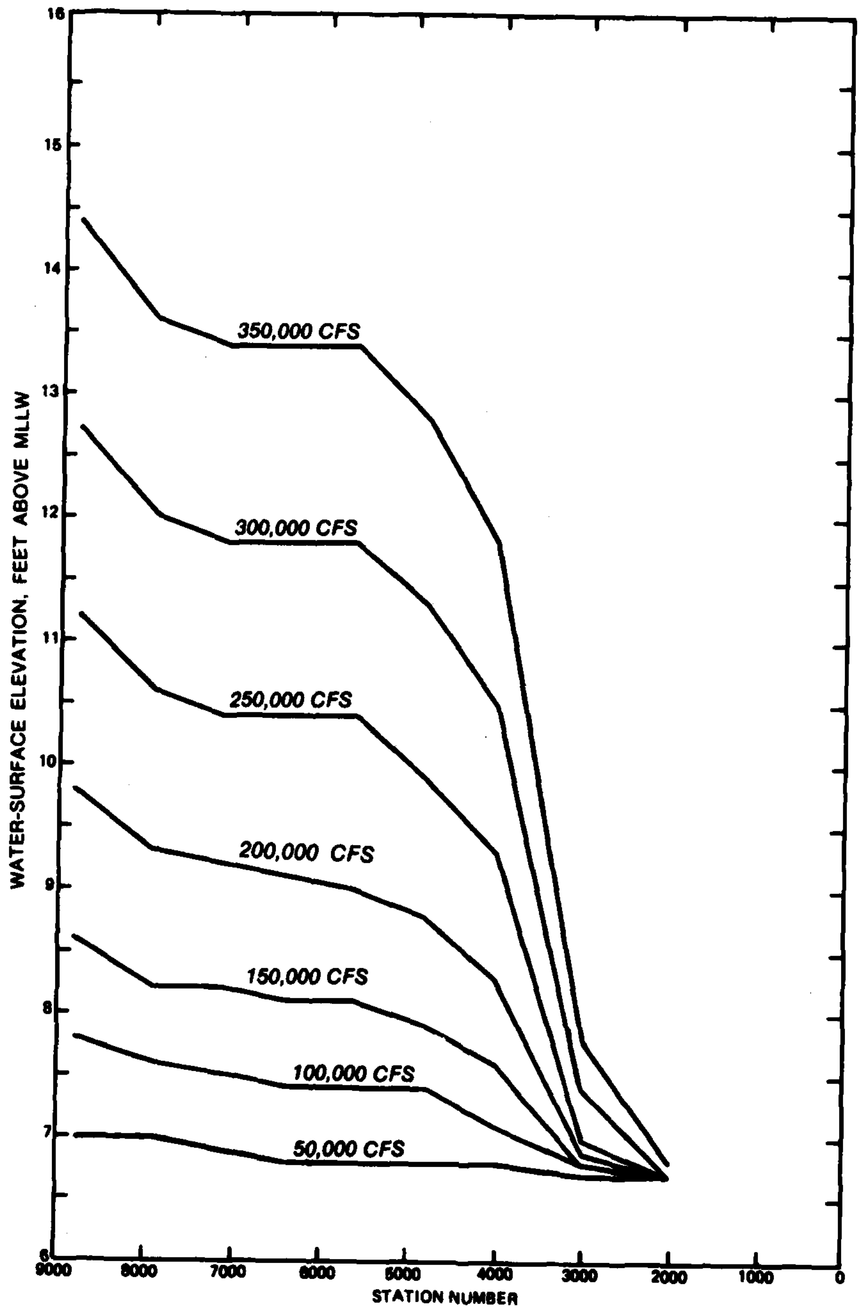


NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET REFERRED TO MEAN LOWER LOW WATER (MLLW).

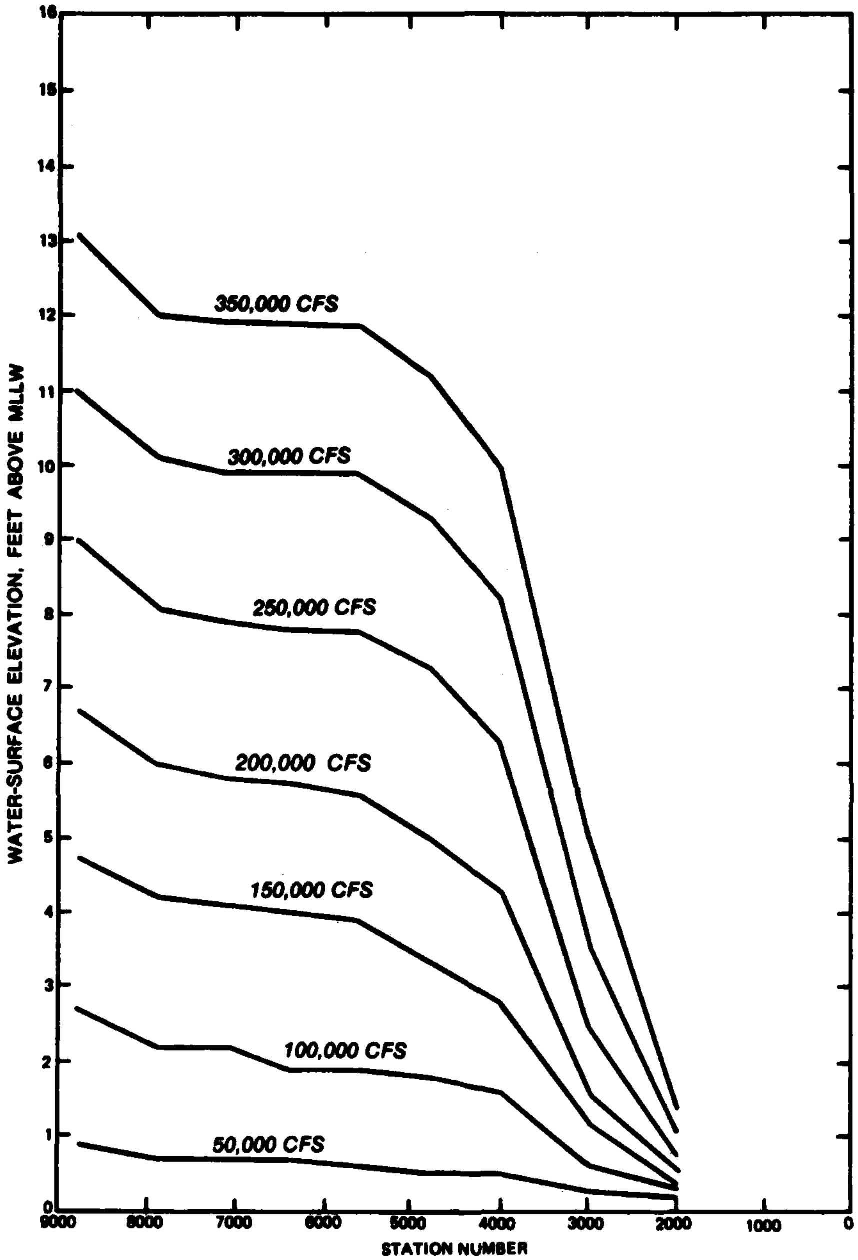
RIVER BED-LOAD MOVEMENT
PLAN 2A
350,000-CFS RIVER DISCHARGE



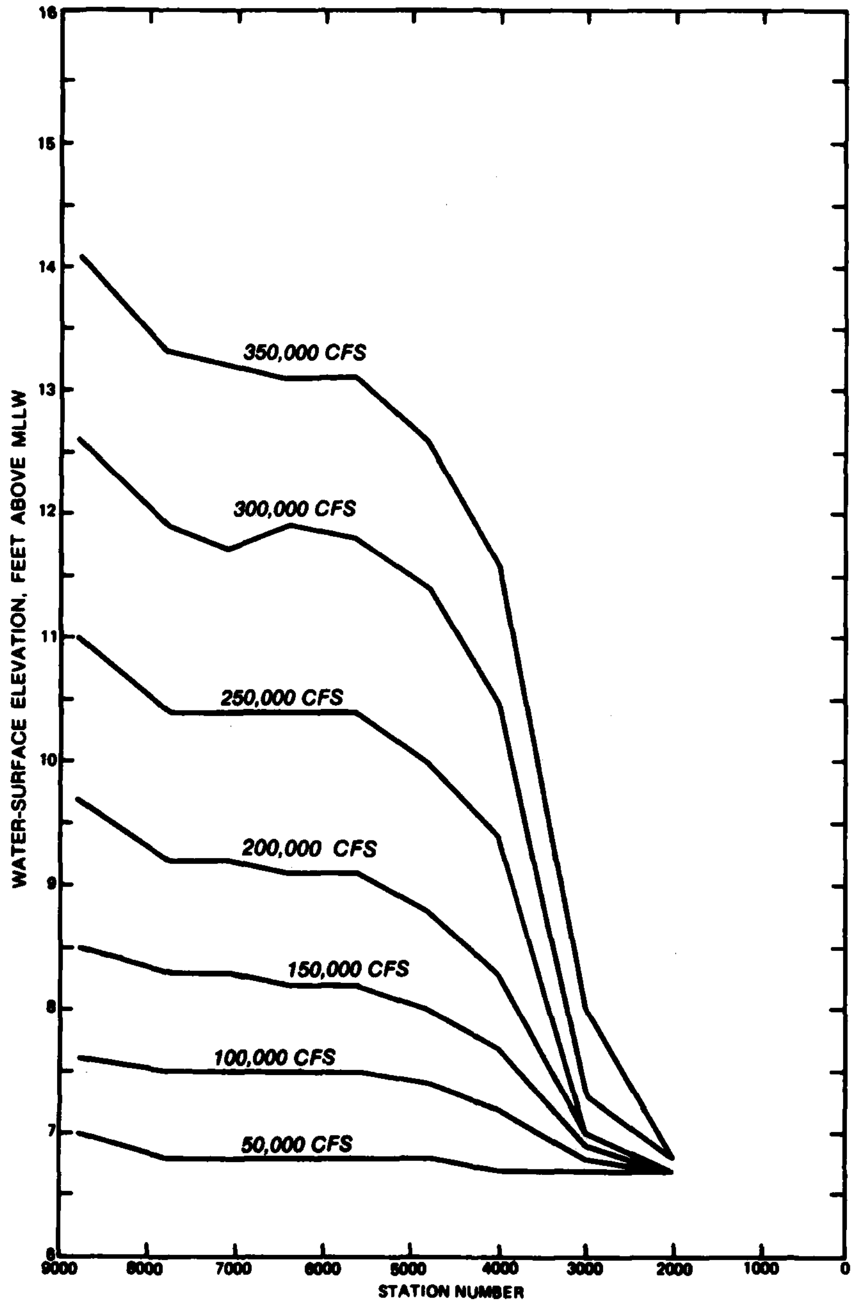
WATER-SURFACE PROFILES
PLAN 3
SWL = 0.0 FT



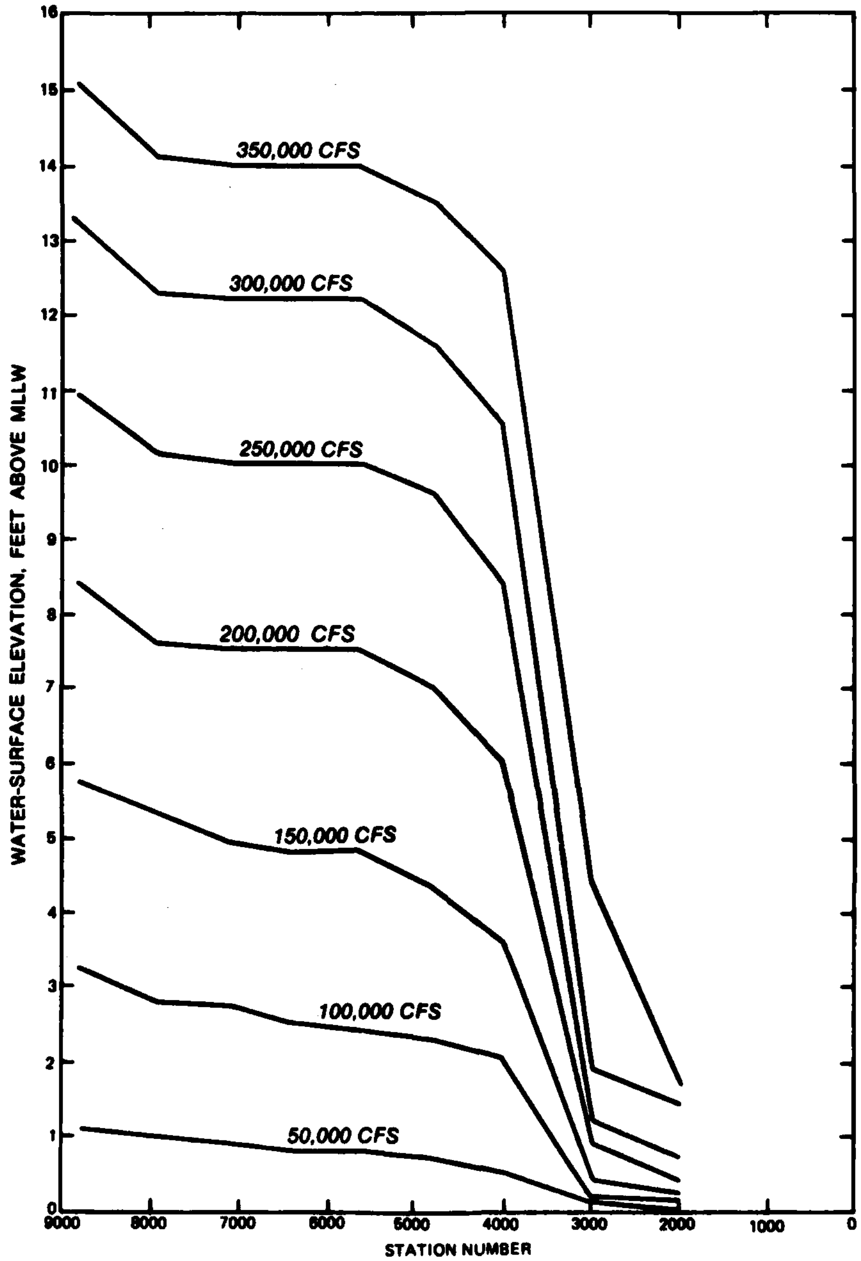
WATER-SURFACE PROFILES
PLAN 3
SWL = +6.7 FT



WATER-SURFACE PROFILES
PLAN 3A
SWL = 0.0 FT

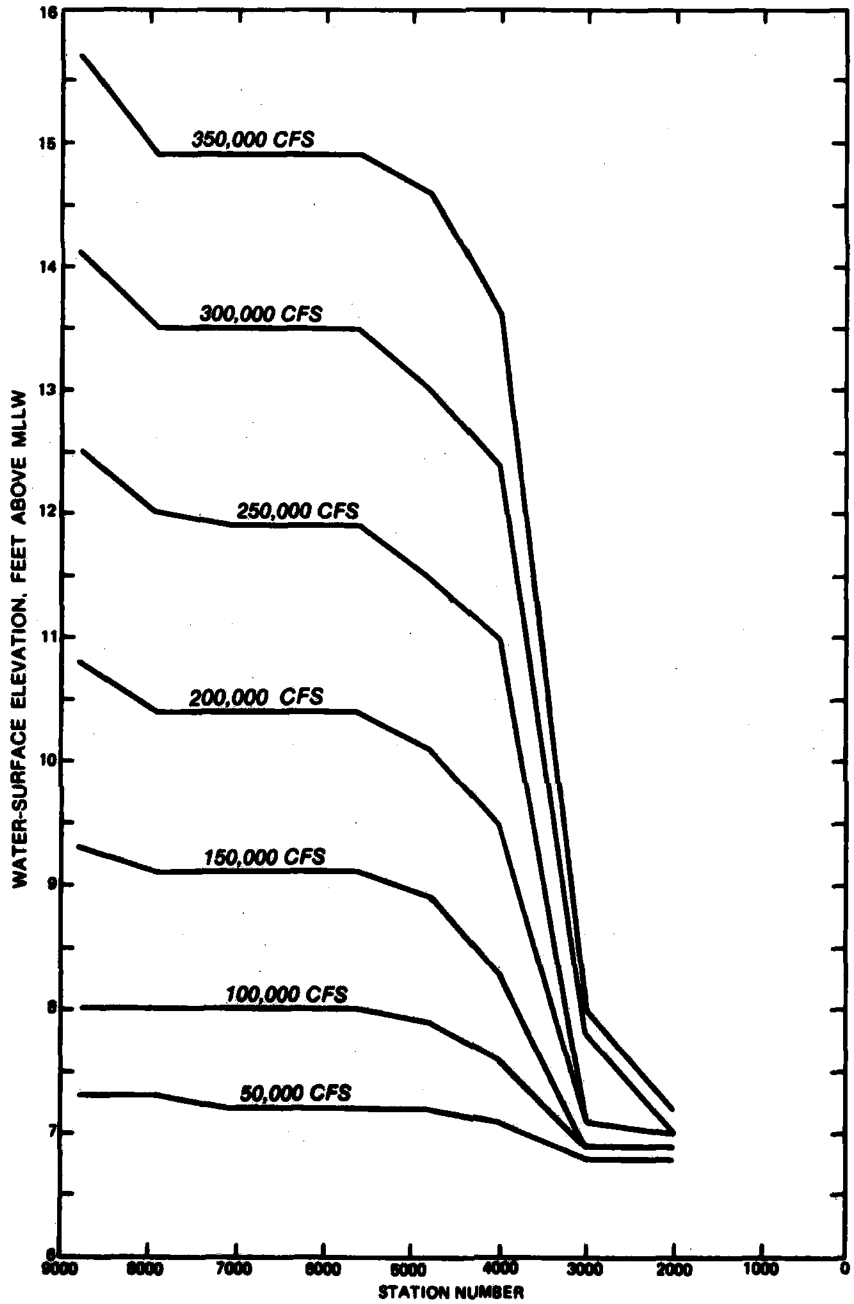


WATER-SURFACE PROFILES
PLAN 3A
SWL = +6.7 FT

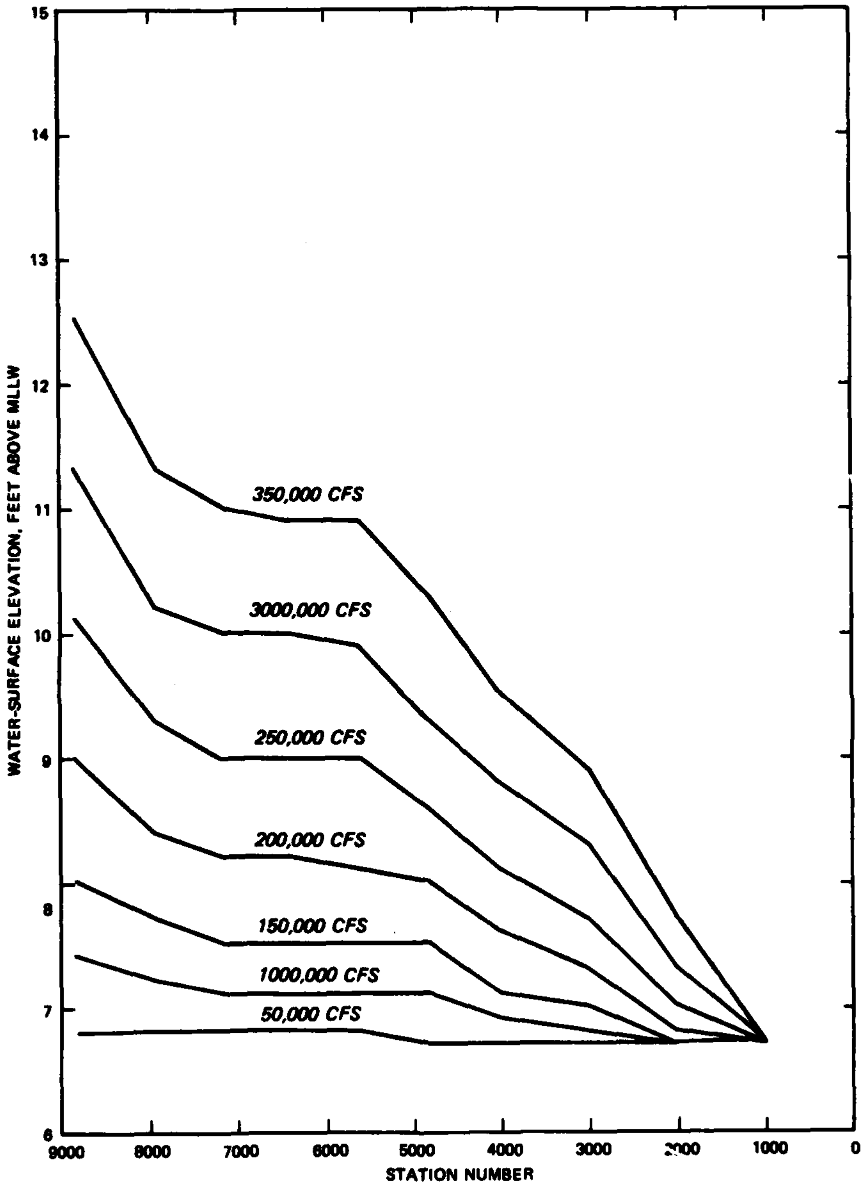


WATER-SURFACE PROFILES
PLAN 3B
SWL = 0.0 FT

PLATE 36

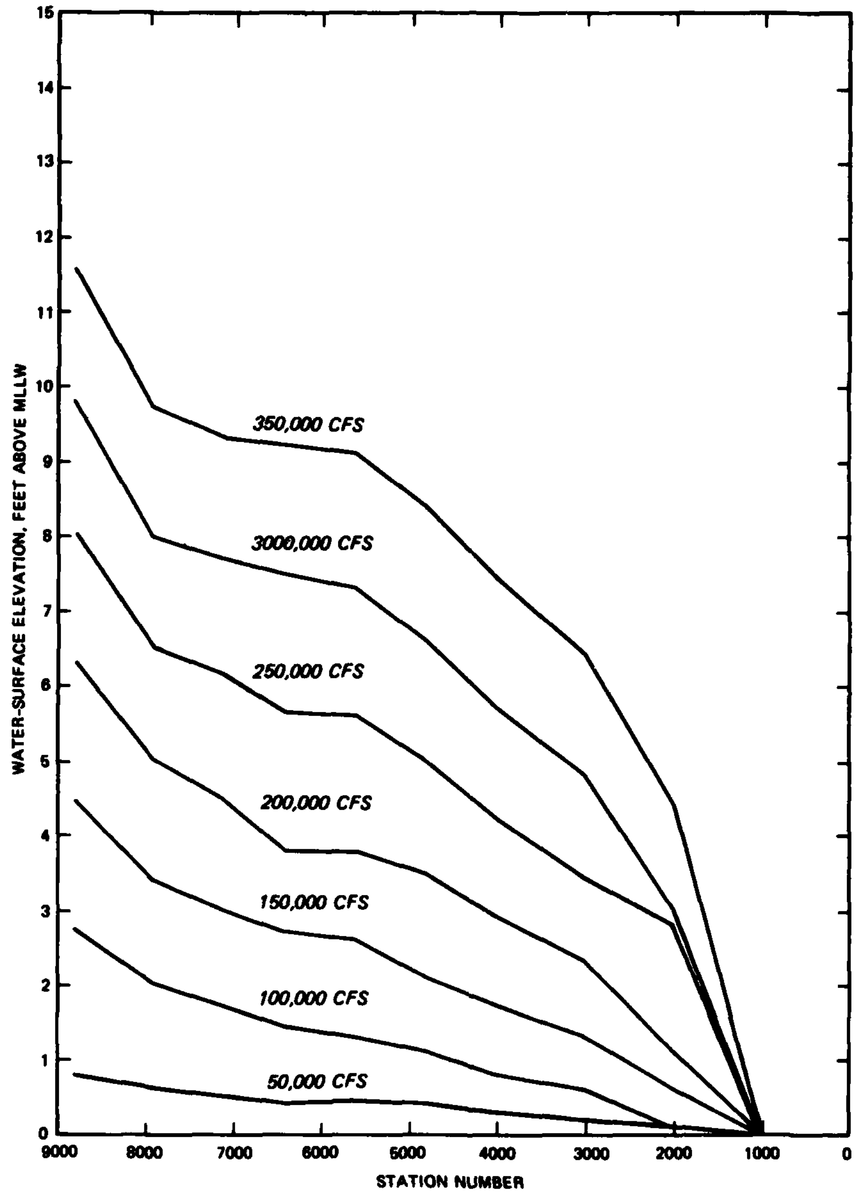


WATER-SURFACE PROFILES
PLAN 3B
SWL = +6.7 FT



WATER-SURFACE PROFILES
PLAN 7J
SWL = + 6.7 FT

PLATE 38

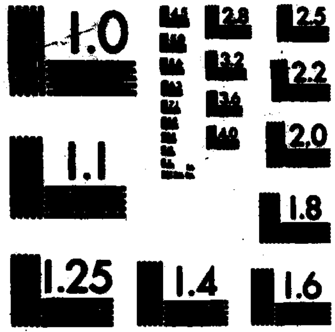


WATER-SURFACE PROFILES
PLAN 7J
SWL = 0.0 FT

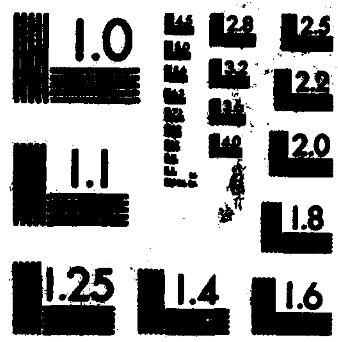
AD-A120 826 DESIGN FOR FLOOD CONTROL WAVE PROTECTION AND PREVENTION OF SHOALING ROGUE..(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN 7/7

UNCLASSIFIED AUG 82 WES/TR/HL-82-18 F/G 13/2 NL

END



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
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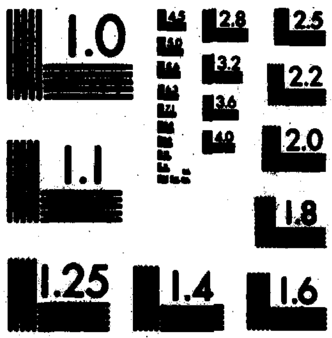
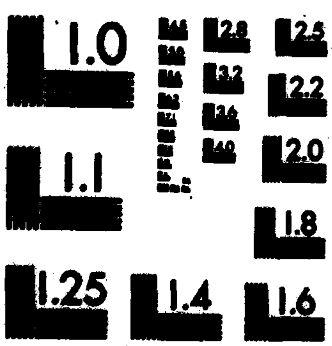
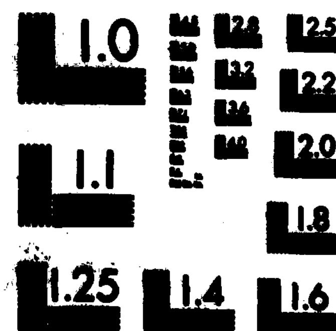


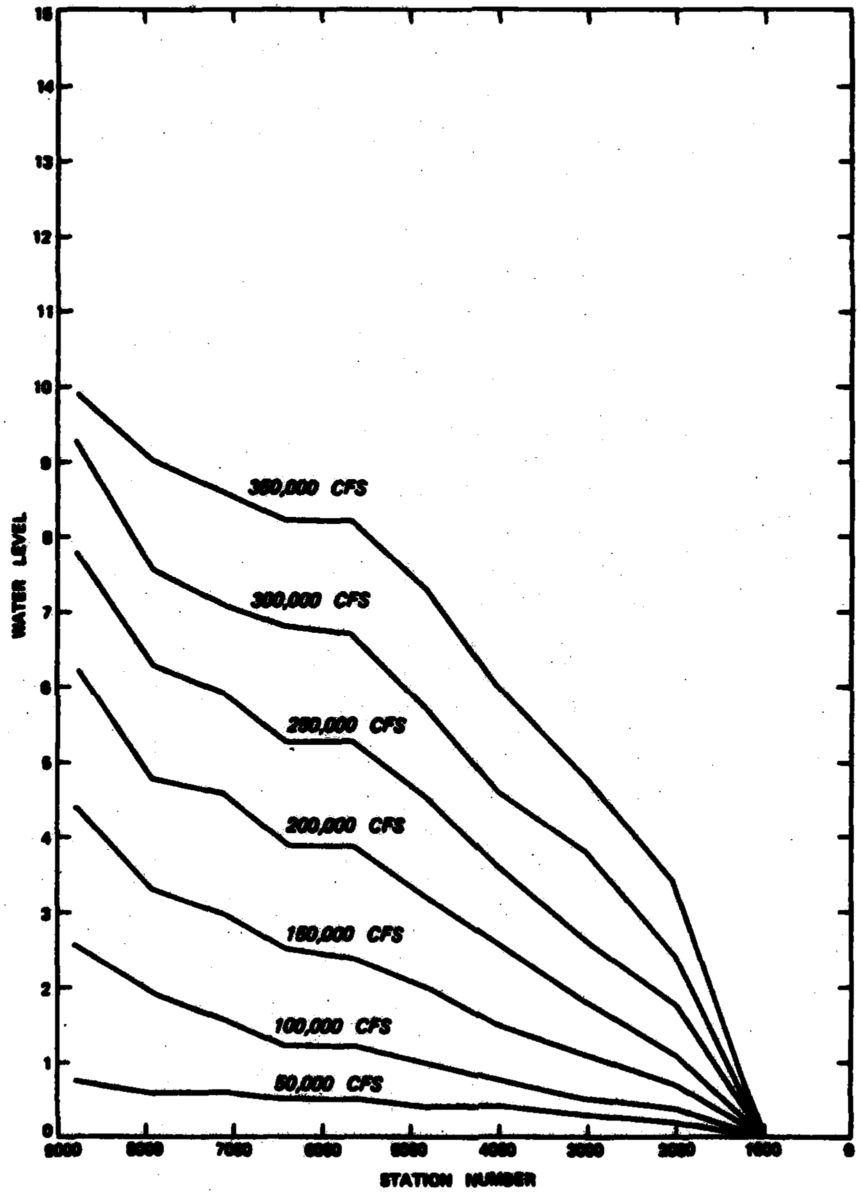
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



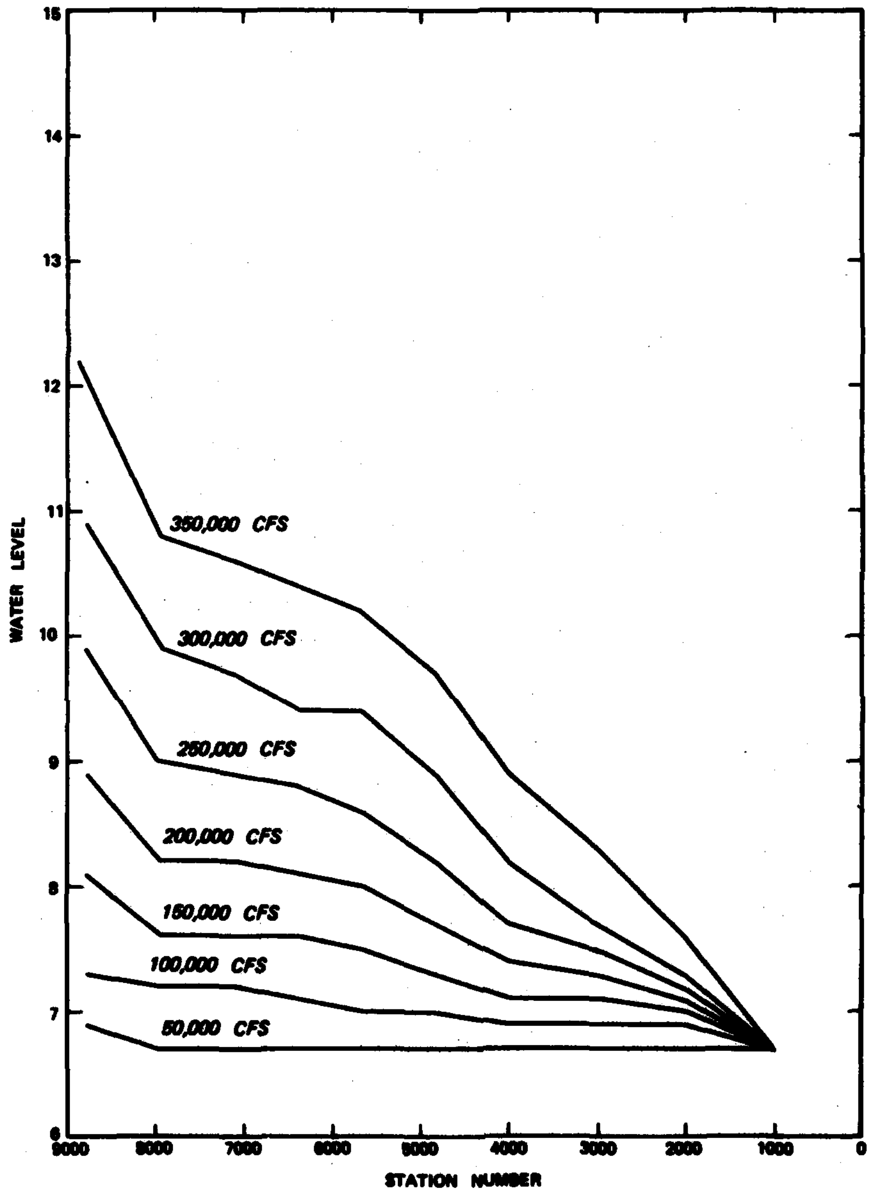
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



WATER-SURFACE PROFILES
PLAN 8D
SWL = 0.0 FT



WATER-SURFACE PROFILES

PLAN 8D

SWL = +6.7 FT

APPENDIX A: NOTATION

A	Area
b	Shallow-water othogonal spacing
b_o	Deepwater orthogonal spacing
$(b_o/b)^{1/2}$	Refraction coefficient, K_r
D_{50}	Median particle diameter
H	Shallow-water wave height
H_o	Deepwater wave height
$H_{1/3}$	Significant wave height
K_r	Refraction coefficient
K_s	Shoaling coefficient
L	Length
n	Manning's roughness coefficient
Q	Discharge
T	Time
V	Velocity
$\forall$	Volume
γ	Specific weight
γ'	Apparent specific weight
η_D	Ratio of median particle diameter
η'_{γ}	Ratio of apparent specific weights
λ	Horizontal scale
μ	Vertical scale

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Bottin, Robert R.
Design for flood control, wave protection and prevention of shoaling Rogue River, Oregon : Hydraulic Model Investigation / by Robert R. Bottin, Jr. (Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. ; available from NTIS, 1982.
111 p. in various pagings, 424 p. of photos, 41 p. of plates : ill. ; 27 cm. -- (Technical report ; HL-82-18)
Cover title.
"August 1982."
Final report.
"Prepared for U.S. Army Engineer District, Portland."
Bibliography: p. 57-58.

1. Flood control. 2. Hydraulic models. 3. Hydraulic structures. 4. Rogue River (Ore.) I. United States. Army. Corps of Engineers. Portland District. II. U.S. Army Engineer Waterways Experiment Station. Hydraulics

Bottin, Robert R.
Design for flood control, wave protection : ... 1982.
(Card 2)

Laboratory. III. Title IV. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; HL-82-18.
TA7.W34 no.HL-82-18